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ABSTRACT

To convey to those who have had no experience with computer-assisted instruction an impression of the experience that students have in a CAI course, this report presents in print the sequence of instruction that one student received from one chapter of the course, Computer Assisted Remedial Education (CARE 1): Introduction to the Education of Exceptional Children. In addition to the content outlines, and pictures of the cathode ray tube throughout, comment is provided to make clear the flow of the course. (EM 011 037 through EM 011 043, EM 011 046, EM 011 047, and EM 011 049 through EM 011 058 are related documents.) (RH)

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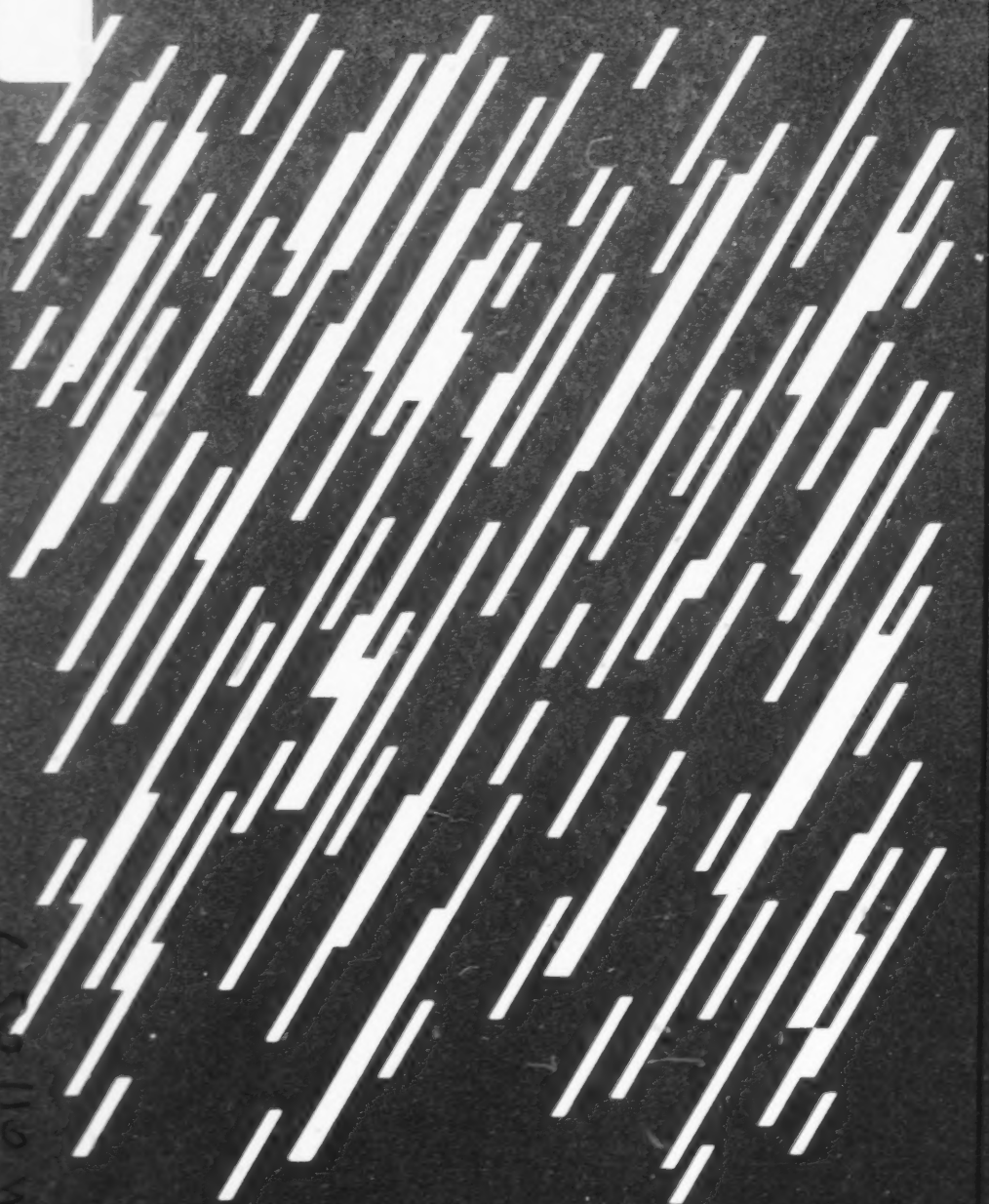
THE COMPUTER ASSISTED INSTRUCTION LABORATORY
THE PENNSYLVANIA STATE UNIVERSITY

Report No. R-53

# Sample Computer Assisted Instruction Student Interactions

K. A. Hall
G. P. Cartwright
C. A. Cartwright
H. E. Mitzel
S. P. Wetcher



EM 011 657

Note to accompany the Penn State Documents.

In order to have the entire collection of reports generated by the Computer Assisted Instruction Lab. at Penn State University included in the ERIC archives, the ERIC Clearinghouse on Educational Media and Technology was asked by Penn State to input the material. We are therefore including some documents which may be several years old. Also, so that our bibliographic information will conform with Penn State's, we have occasionally changed the title somewhat, or added information that may not be on the title page. Two of the documents in the CARE (Computer Assisted Remedial Education) collection were transferred to ERIC/EC to abstract. They are Report Number R-36 and Report Number R-50.

Jaclyn Cassell: /ERIC/EM

ED 076055

# SAMPLE COMPUTER ASSISTED INSTRUCTION STUDENT INTERACTIONS

K. A. Hall, G. P. Cartwright, C. A. Cartwright,
H. E. Mitzel, and S. P. Wetcher

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
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Report No. R-53

The Pennsylvania State University
Computer Assisted Instruction Laboratory

December, 1972

In November of 1970, the staff of the Pennsylvania State University inaugurated a new and sophisticated computer mediated instructional technology into its inservice continuing education program for teachers. The instructional program in special education is designed to assist regular classroom teachers in identifying the problems of handicapped children. The instructional program is given a wide audience by means of a specially designed Mobile Computer Assisted Instruction Laboratory. Since the beginning of the project, the Mobile CAI Laboratory has offered high quality college instruction to over 1,000 educators per year.[1] A continuing interest of the University is to convey to others, many of whom have had no experience with computer-assisted instruction (CAI), a description, a feeling, or a flavor of the experience that the students (inservice teachers) have when they take the program of instruction. This report attempts to meet this goal by presenting in print the sequence of instruction that one student received from one chapter of the course while seated at his student station. Some background "stage setting" information is included also to help the reader recreate the "experience."

## CARE

Professors G. Phillip Cartwright and Carol A. Cartwright led a team of University faculty members in developing the graduate level course entitled, "Computer Assisted Remedial Education (CARE 1): Introduction to the Education of Exceptional Children." The purpose of the course is to give educational personnel the knowledge and skills necessary to deal effectively with children who have educational problems.

The CARE course is designed to prepare inservice preschool and primary level elementary teachers and other interested persons to know the characteristics of, and be able to identify, handicapped children. Handicapped children are defined, for purposes of this course, to be those children who have atypical conditions or characteristics which have relevance for educational programing. Handicapped children include children who display deviations from normal behavior in any of the following domains: a) cognitive, b) affective, and c) psychomotor.

The philosophy of the course is such that teachers are encouraged to look at children as individuals. The use of traditional categories or labels is minimal. However, certain terms and concepts related to handicapping conditions are taught so that persons who take this course are better able to communicate with other professionals in the field.

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[1] The Mobile CAI Laboratory is currently supported by The Pennsylvania State University, the Penn State Foundation, and a grant from the Bureau of Educational Personnel Development, U. S. Office of Education. The development of the CARE course for computer presentation was funded by a grant from the Bureau of Education for the Handicapped, U. S. Office of Education.

Upon completion of CARE 1, participants will have achieved the following major objectives. These overall objectives are, of course, broken down into a series of sub-objectives and tasks–over 1,100 in all. Participants will:

A. Know the characteristics of handicapped children and be aware of symptoms which are indicative of potential learning problems;

B. Be able to screen all children in regular classroom programs for deviations and determine the extent of the inter-individual differences;

C. Be able to select and use for those children with deviations appropriate commercial and teacher-constructed appraisal and diagnostic procedures in order to obtain more precise information as to the nature of the deviation;

D. Be able to synthesize information by preparing individual profiles of each child's strengths and weaknesses on educationally relevant variables;

E. Be able to evaluate the adequacy of the information available in order to make appropriate decisions about referral to specialists;

F. Be able to prepare adequate documentation for the case if the decision to refer is affirmative.

It is expected that the teachers who exhibit the competencies listed above will systematically evaluate children's learning potential and formulate appropriate educational plans.

## Facilities

To implement this program, a custom-built expandable van was fitted with a small, stand-alone computer and fifteen student stations (IBM 1500 Instructional System). Each student station (Figure 1) is equipped with a small cathode ray tube (CRT) on which is displayed alphameric information plus a wide variety of graphics including animated illustrations. Student response components of the CRT include a typewriter-like keyboard with upper and lower case characters and a variety of special characters and a light-sensitive pen used by the learner in making responses to displayed material. In addition to the CRT, each student station has a rear screen image projector on which are displayed color photographic images. A 1,000-frame reel of microfilm, with each frame separately addressable by the computer, is used in the image projector. The third major display component is an audio device with separately addressable pre-recorded messages played through a headset for each individual student.

Figure 1.
Student at the Computer-Assisted Instruction Terminal.

## Implementation

On a pre-arranged schedule, the Mobile CAI Laboratory is moved to a school in a rural community and connected to electric, telephone and water services. Over the next seven weeks, in late afternoon and evening hours, elementary teachers and their supervisors schedule themselves for one-to-three-hour sessions at computer student stations on flexible and irregular schedules to fit into the demands of their personal lives. During a seven week period the Mobile CAI Laboratory will accommodate approximately 125 to 150 learners who enroll for a typical three credit college level course. The students, of course, put in considerable time in home study of a 400 page textbook which accompanies the course. The Mobile Laboratory and this utilization plan are sufficient for providing instruction to more than 1,000 educators during a calendar year. However, the existing computer has sufficient power and capacity to support 15 additional student stations which would double the number of students served. Currently, the existing student stations and relocation scheduled every six weeks meet the needs of the target audience in a 25 mile radius.

## Sample Instructional Sequence

A portion of Chapter 7, "Individual Differences and Normality," (written by Professor Harold E. Mitzel) was chosen for this presentation because of the wide variety of instructional strategies, presentation and response modes, and learning task complexities contained in the material. Chapter 7 develops teacher competencies in the area of educational measurement to enable the inservice teacher to properly interpret test scores which are commonly available to him in his school. Much of the content in Chapter 7 is intended to help teachers understand that a certain amount of deviation from the average is to be expected and that children should not be considered atypical if they deviate only slightly from the average.

For illustrative purposes, three components are presented for each section of instruction: 1. Content Outline, 2. Behavioral Objectives, and 3. Student Interactions. The content outline and the behavioral objectives are traditional in nature and are included to assist the reader of this document in understanding the student interactions. They are *not* presented to the student as he is taking the course.

The Student Interactions include material presented on the cathode ray tube, the image projector, and through the audio unit. Comments regarding the flow and sequence of the material are included. The key to the Student Interactions is presented in Table 1. In the live CAI situation, students need about two hours to complete the Chapter. For purposes of this document only, several portions of the chapter are excluded. Not all branches are shown and a number of sections are reduced in scope once the general format has been established.

Table 1
Key to Student Interactions

| Item | Symbol | To the Student Working at the CAI Terminal | To the Reader of this Document |
|---|---|---|---|
| Cathode Ray Tube | *CRT* | Light blue figures on dark background | White figures on black background |
| | | Animated–controlled by computer program | Static–animation depicted by time-lapse photography |
| | | | Photographs of cathode ray tube |
| Image Projector | *Image* | Full color, still photographs | Black-and-white still photographs of original art work |
| | | Randomly available under program control | Reference is made to photograph through *Comment* |
| Audio | *Audio* | Recorded audio messages played through headset | Script of spoken messages |
| | | Randomly available under program control | Appear in sequence created by the one student presented |
| | | May be replayed at student option | May be re-read at reader option |
| | *Comment* | | Directs reader through printed materials |
| | | | Describes steps performed by the computer |
| | | | Describes other alternatives used by the student |

## ORGANIZING AND REPRESENTING DATA

### Content Outline

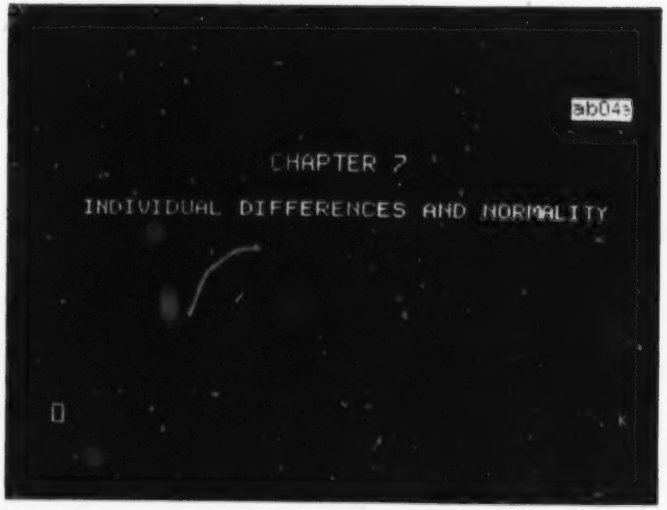
I. Bar Graphs
   A. Present data about frequency or number of cases associated with labeled categories;
   B. Frequency dimension or number scale; only dimensions essential in bar graph

### Behavioral Objectives

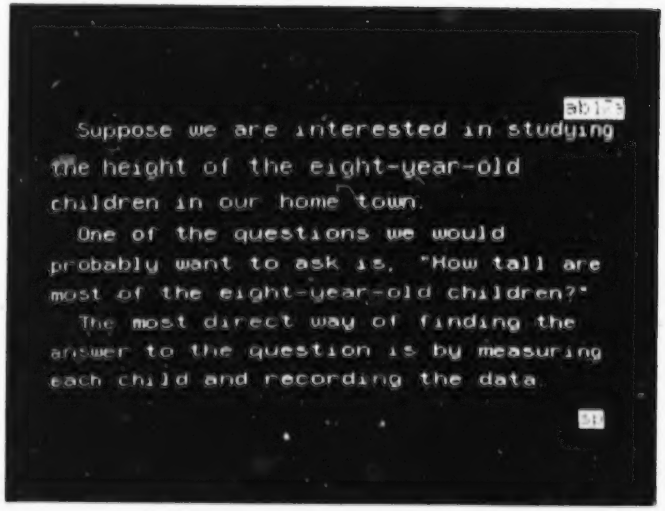
Given heights of children, indicate each child's position on bar graph (alternate choice).
Indicate that one dimension is shown on bar graph (alternate choice).
Recall bar graphs as type of data representation being discussed (completion).

### Student Interactions

*1-CRT*

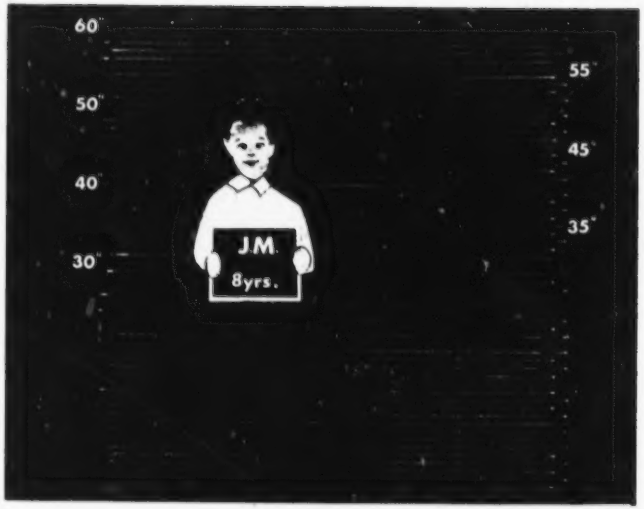



*2-CRT*


Suppose we are interested in studying the height of the eight-year-old children in our home town.
One of the questions we would probably want to ask is, "How tall are most of the eight-year-old children?"
The most direct way of finding the answer to the question is by measuring each child and recording the data.

*3-CRT*

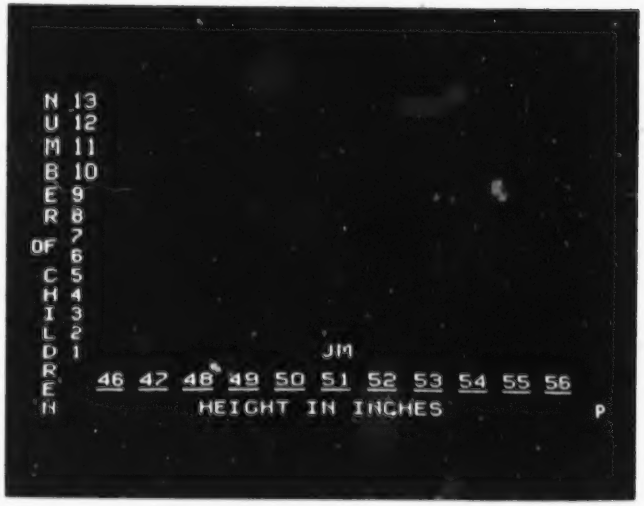
*4-Image*




*5-Audio'*

The name of the child you see on your image projector is John Middleton. You see by his birth certificate that he is 8 years old. By having John stand beside a measuring chart, we determine his height to be 51 inches. Let us record this information on our Cathode Ray Tube. First of all, notice that on the left margin of our screen is NUMBER OF CHILDREN, and at the bottom of the screen is listed HEIGHT IN INCHES. We are going to enter John's height on the screen by placing his initials directly above the number representing his height in inches. Since John Middleton is 51 inches tall, the letters J M will now appear above the number 51.

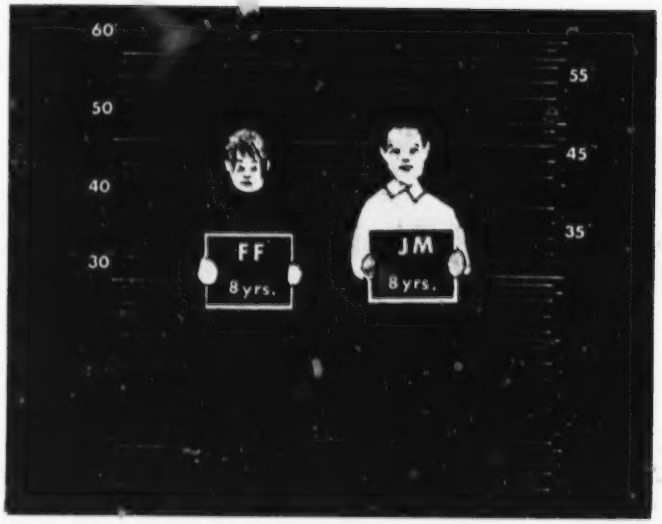
*6-CRT*



*7-Audio*

**Joining John at the measuring chart is Fred Fox. Fred, as we can see by his birth certificate, is also eight years old. But he is not as tall as John. Fred is only 48 inches tall. You can record Fred Fox's height on the screen by placing your light pen on the number representing Fred's height in inches.**

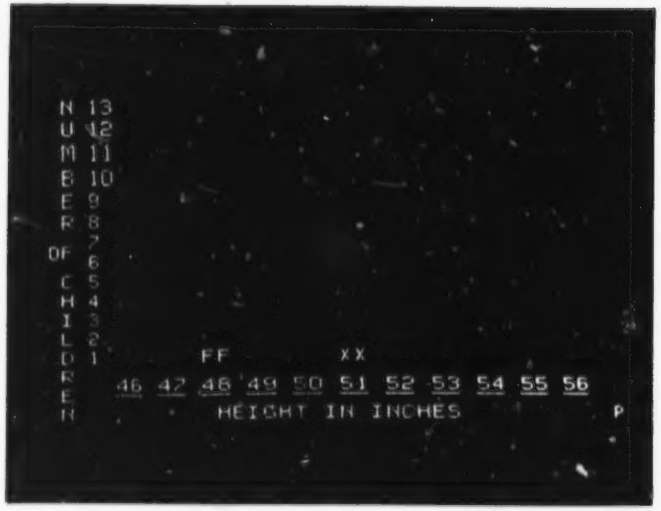
*8-Image*



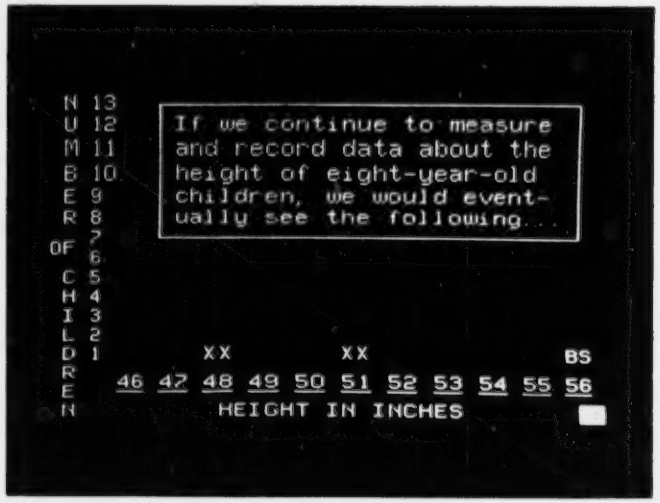

*9-Comment*

*The P in the lower right corner of 10-CRT informs the student that he is required to make a light pen response. When the student touches "48" with the light pen, the computer places "FF" in the proper position to indicate to the student that he has correctly recorded the height of Fred Fox. The computer will then replace "FF" with "XX" as one step in building the bar chart shown completed in 13-CRT.*

*10-CRT*



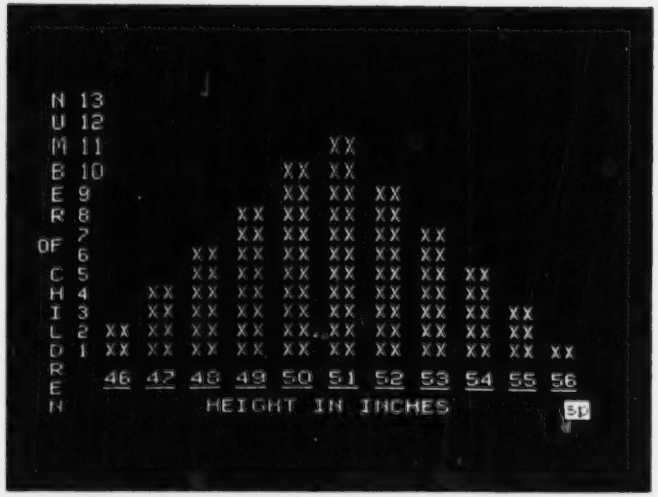
*11-CRT*


If we continue to measure and record data about the height of eight-year-old children, we would eventually see the following...
NUMBER OF CHILDREN
XX XX BS
46 47 48 49 50 51 52 53 54 55 56
HEIGHT IN INCHES

*12-Comment*

*As the student watches, the program builds the bar graph illustrated in the completed stage in 13-CRT.*

*13-CRT*




*14-Audio*

**What we have constructed is essentially a vertical bar chart in which each pair of XX's represents one unit or one individual.**

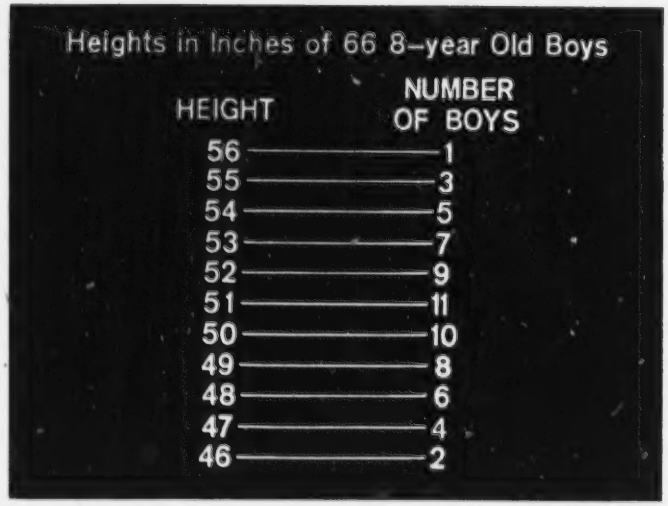
*15-Comment*

*Several short-answer problems follow (not shown here) to provide the student with further tests of his acquisition of the important objectives.*

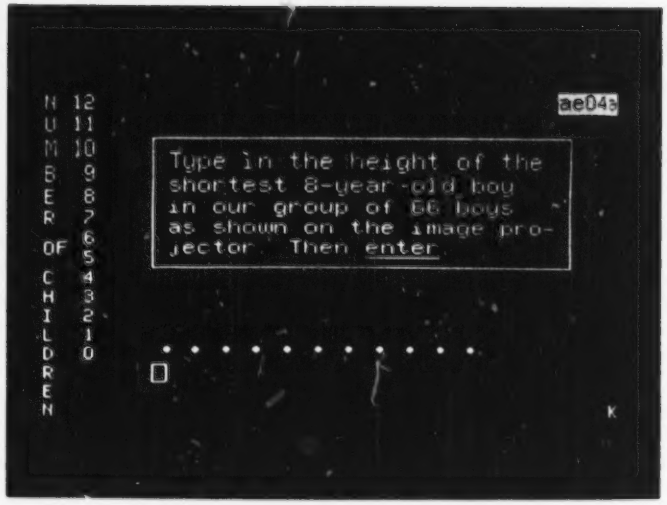
| Content Outline | Behavioral Objectives |
|---|---|
| II. Histograms | |
| A. Two-dimensional frequency chart | |
| 1. Frequency represented by vertical bars | |
| 2. Unit of measurement represented on horizontal scale | |
| B. Continuous variation | |
| 1. Given measurement extends one-half unit below and one-half unit above measured value. | Type heights of children along horizontal axis of histogram (constructed response)<br>Conclude that 3 units on bar of histogram represent frequency of 3 (constructed response)<br>Conclude that the total number of units of a histogram represent the total frequency of the data (constructed response) |

**Student Interactions**

*16-Image*



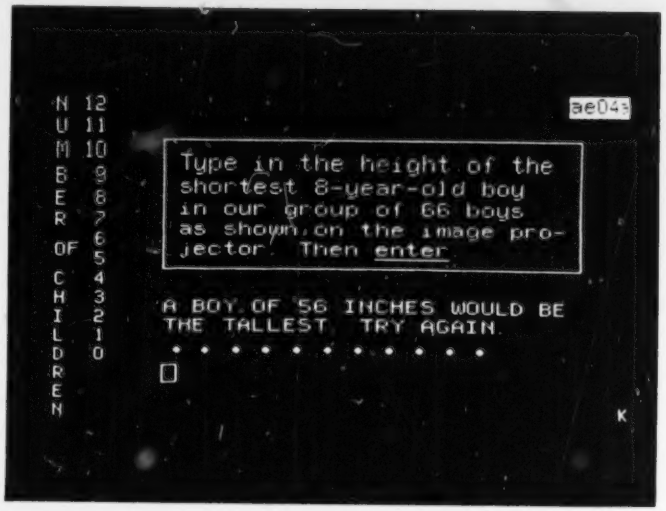

*17-CRT*



*18-Comment*

*The student responded "56" which is incorrect (19-CRT). The response has been erased and appropriate feedback given. The cursor (small rectangular shape) and the "K" in the lower right corner of the screen indicate to the student that he is expected to respond again.*

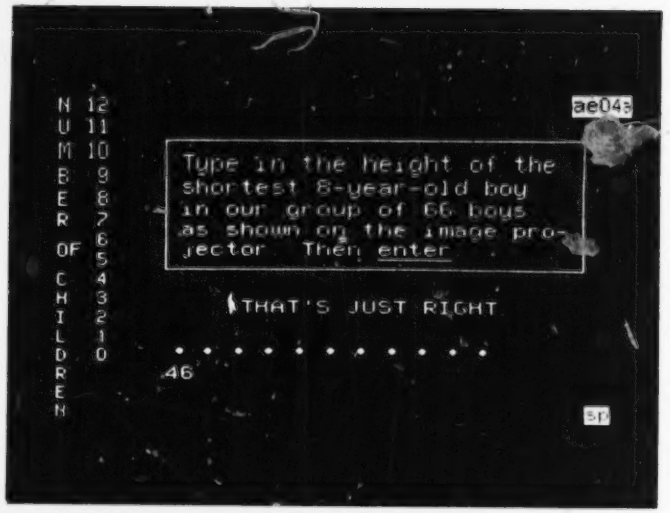
*19-CRT*



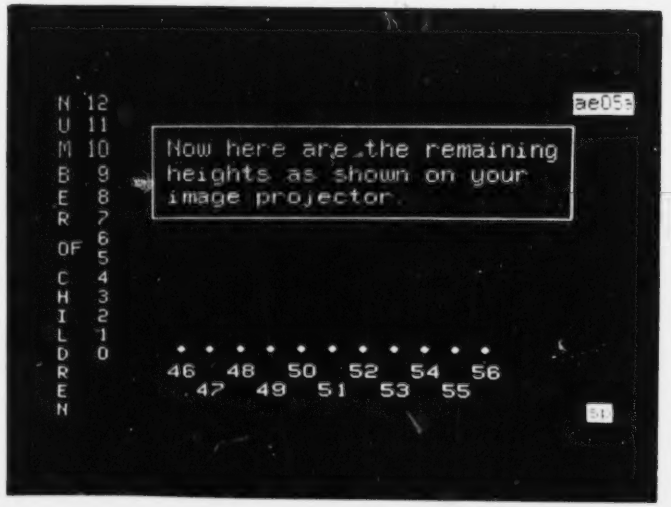

*20-Comment*

*The student responded "46" and received the feedback, "THAT'S JUST RIGHT," as shown in illustration 21-CRT.*

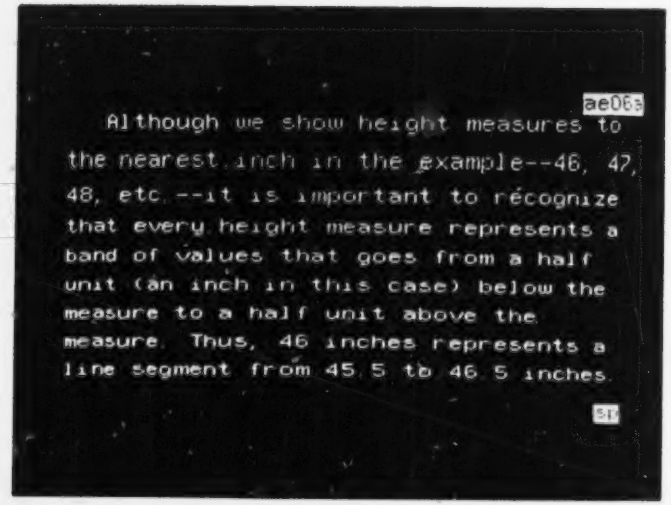
*21-CRT*



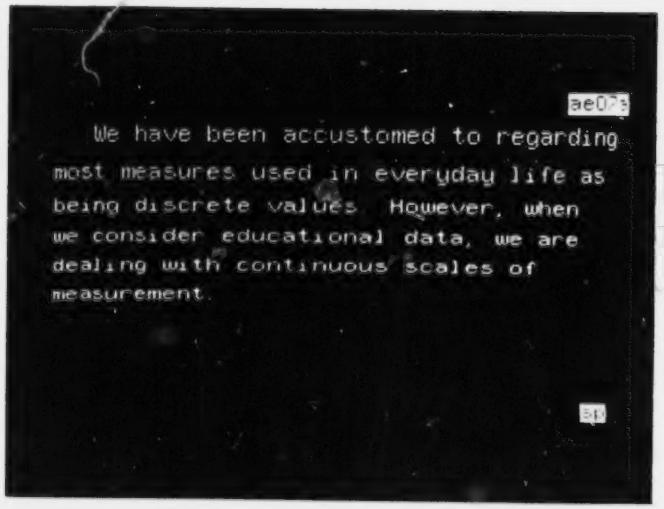
*22-CRT*



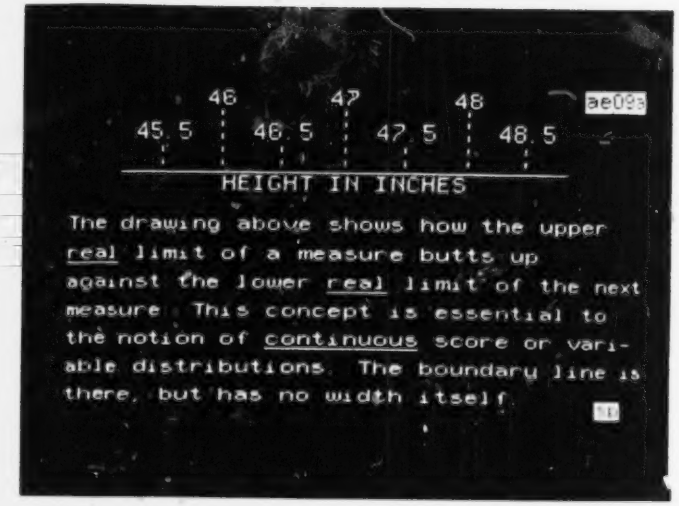

*23-CRT*


ae06a
Although we show height measures to the nearest inch in the example--46, 47, 48, etc.--it is important to recognize that every height measure represents a band of values that goes from a half unit (an inch in this case) below the measure to a half unit above the measure. Thus, 46 inches represents a line segment from 45.5 to 46.5 inches.

*24-CRT*


ae07a
We have been accustomed to regarding most measures used in everyday life as being discrete values. However, when we consider educational data, we are dealing with continuous scales of measurement.

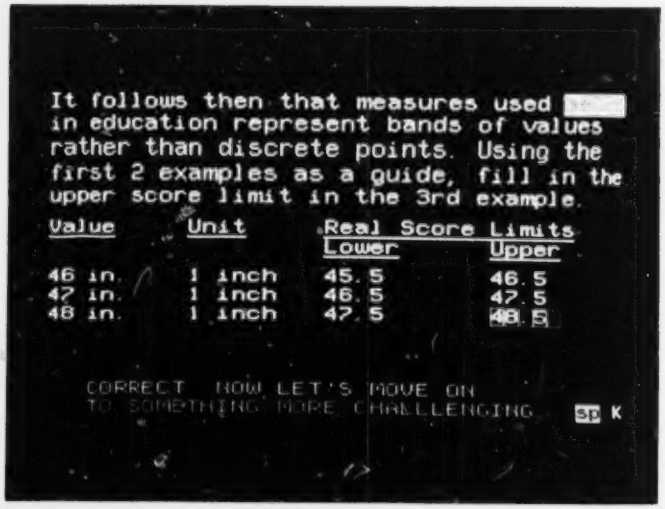
*25-CRT*


ae09a
46
47
48
45.5
46.5
47.5
48.5
HEIGHT IN INCHES
The drawing above shows how the upper real limit of a measure butts up against the lower real limit of the next measure. This concept is essential to the notion of continuous score or variable distributions. The boundary line is there, but has no width itself.

*26-Comment*

*27-CRT shows that the student responded "48.5" and received feedback. The lines around "48.5" are the result of time-lapse photography and the movement of the cursor as the student responded.*

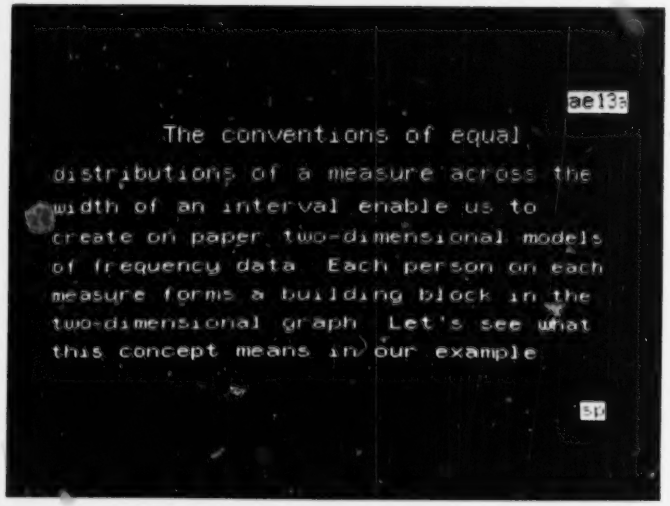
*27-CRT*




*28-Comment*

*Additional practice problems (not shown here) are presented before the following text is presented.*

*29-CRT*

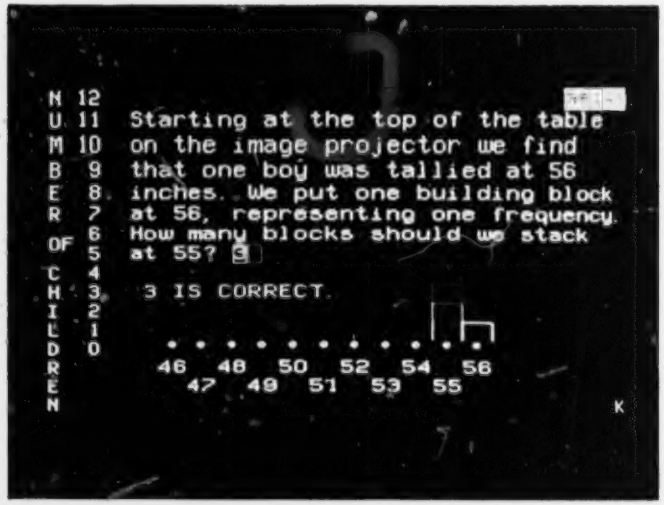

ae13
The conventions of equal distributions of a measure across the width of an interval enable us to create on paper two-dimensional models of frequency data. Each person on each measure forms a building block in the two-dimensional graph. Let's see what this concept means in our example
SP

*30-Comment*

*16-Image is still visible to the student on the image projector and is referred to in the following interactions.*

*Time-lapse photography (31-CRT) shows that the student responsed "3," received feedback, "IS CORRECT," and is shown how that quantity is represented on the graph.*

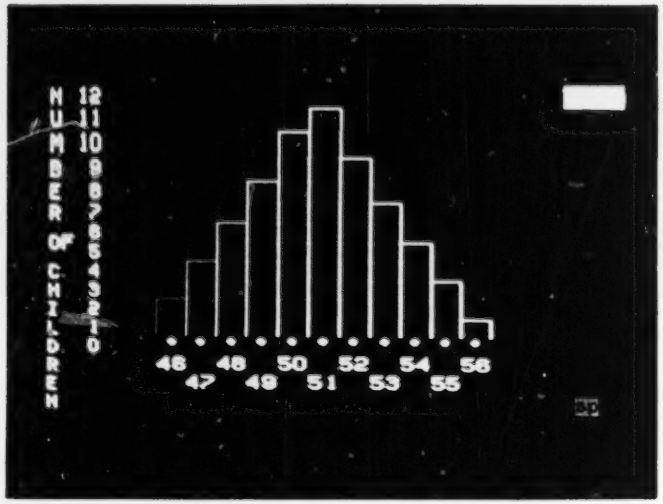
*31-CRT*



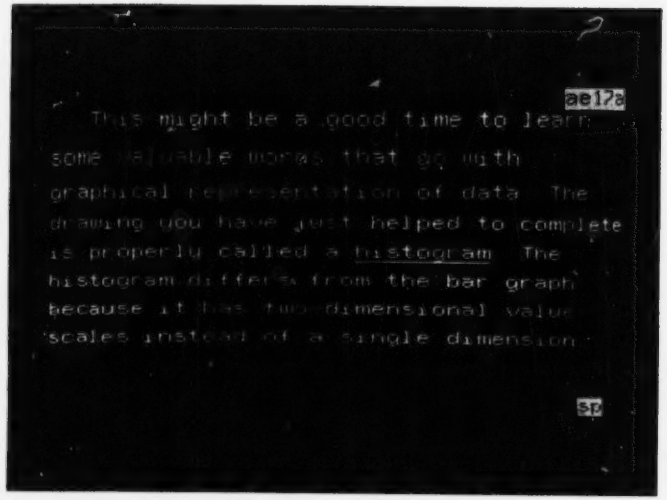

*32-Comment*

*After the student has determined the total number of blocks in the graph by referring to 16-Image, the graph is constructed for the student in real time on the CRT.*

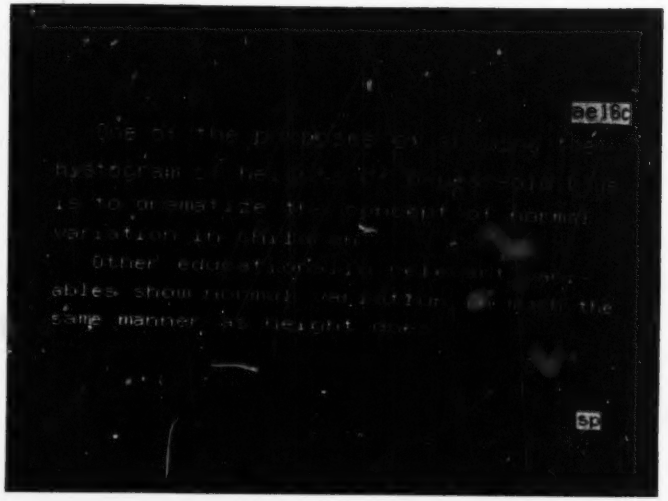
*33-CRT*



*34-CRT*


ae17a
This might be a good time to learn
some valuable words that go with
graphical representation of data. The
drawing you have just helped to complete
is properly called a histogram. The
histogram differs from the bar graph
because it has two dimensional value
scales instead of a single dimension.
sp

*35-CRT*


ae18c
sp

# FREQUENCY CURVE

## Content Outline

I. Normal Curve of Error–Theory
   A. Two dimensions: frequency and scale value
   B. Elements of scale dimension bear relationship to one another
   C. Formed by connecting top of each interval column of histogram
   D. If unit of histogram, reduced to very small widths, smooth curve created which often has "bell shape"
      1. vertical dimension represents number of cases or frequencies
      2. horizontal dimension represents continuous scale or measure
      3. frequencies tend to pile up in middle of distribution and be extremely few at extremes
      4. total area under curve proportional to total frequency
         a. curve is symmetrical–50% of area falls below exact center of distribution and 50% falls above
      5. curved line approaches but never quite touches base line
   E. Characteristics of normal curve are described precisely by mathematical formula called "Incomplete Beta Function"

## Behavioral Objectives

Recall frequency as term for the number of cases in a distribution (short answer)

Recognize that the horizontal dimension represents a continuous scale of measurement (multiple choice)

Recall that cases tend to pile up in the middle of a distribution (completion)

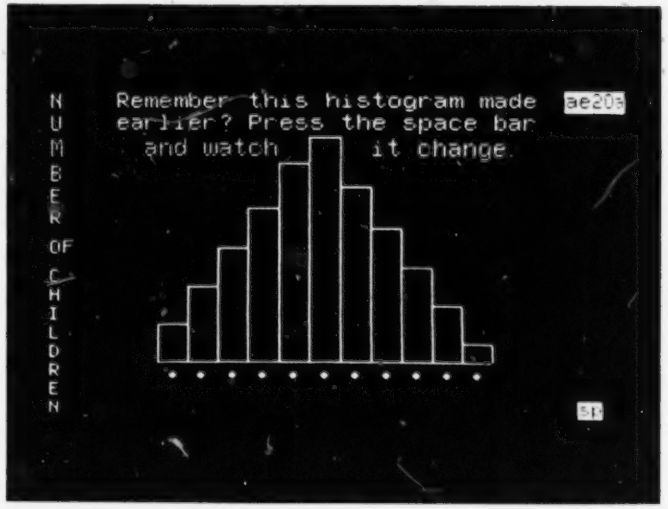
Conclude that 50% of the area falls in the left half of the distribution (short answer)

Conclude that the curved line never quite touches the base line because frequencies at the extremes of the distribution are rare (alternate response)

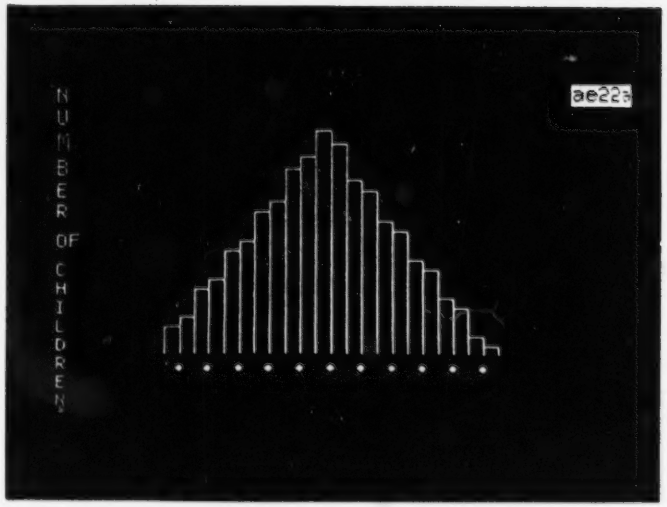
*36-Audio*

**The histograms we have just constructed represent in a graphical way all of the information we have so far about the heights of 66 boys. It would, however, be difficult to manipulate this histogram in order to find a particular child's location in relation to all the other children or to compare the histogram of several groups. In short, histograms are awkward, so we need some other ways of looking at data.**

*37-CRT*



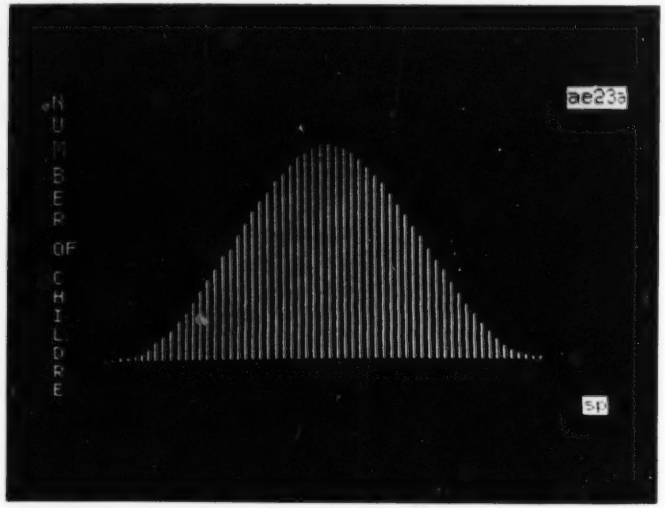

*38-CRT*




*39-Audio*

**If our measures of boy's heights were accurate and recorded to the nearest half inch, the histogram of these measures would look like that shown on the screen now (38-CRT). Remember that the intervals in such an instance would extend one-quarter of an inch below the half-inch label and one-quarter of an inch above the label. If we extended the process to very, very narrow intervals, we would get the following:**

*40-CRT*



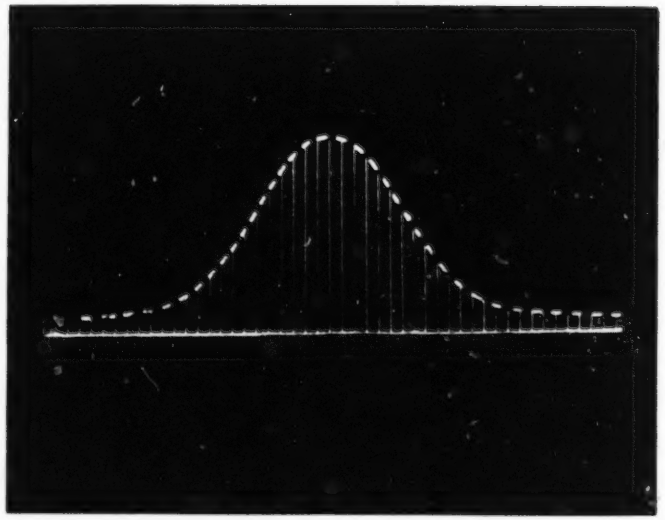

*41-Audio*

The shape of the histogram is partly a function of the number of cases on which measurements are taken. It is both intuitively and scientifically sound to expect small samples to show greater fluctuations or deviations from one another than large samples do.

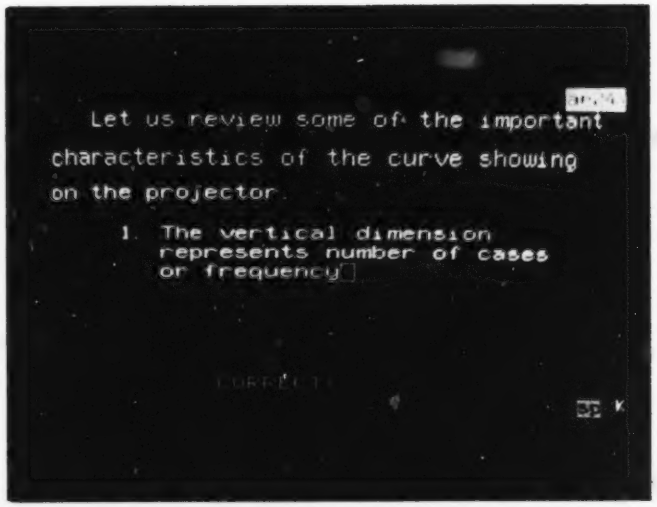
*42-Audio*

In the instance of the heights of boys, we would anticipate a definite smoothing of the tops of the intervals. And, if we had a very large sample, the histogram of the heights of eight-year-old boys would look like that shown on the projector (43-Image). Note that a curved line has been passed through the tops of the histogram columns. For the remainder of this section, we will use the curved line to represent distributions and omit the mass of vertical lines.

*43-Image*



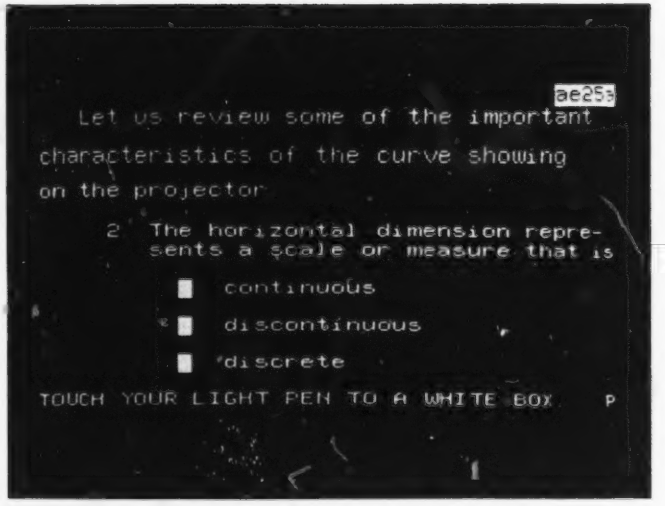
*44-CRT*


Let us review some of the important
characteristics of the curve showing
on the projector.
1. The vertical dimension
represents number of cases
or frequency

*45-Comment*

*The student responded "frequency," received feedback "correct," and is ready to proceed to the next question in the review.*

*46-CRT*

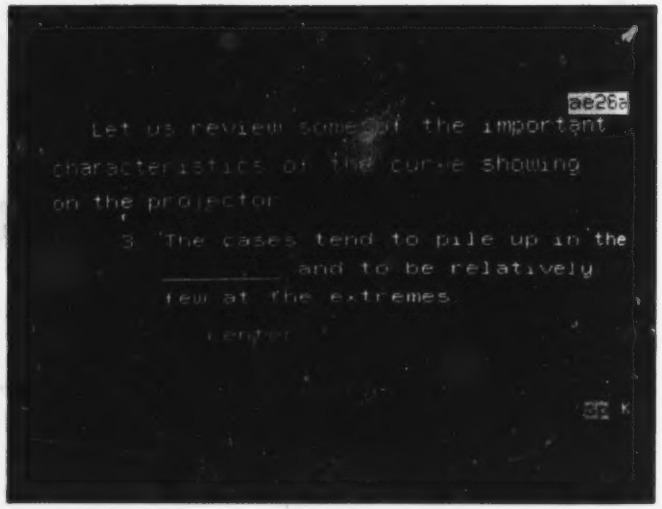



*47-Comment*

*The correct answer (46-CRT) is "continuous." Had the student indicated either of the two wrong responses, the following feedback would have been presented to him:*

*NO. REMEMBER THE BAR GRAPH WHEN THE COLUMNS WERE SEPARATED BY SPACES. IN THAT INSTANCE, THE DISTRIBUTIONS WERE DISCONTINUOUS. LOOK AT THE IMAGE AND TRY AGAIN.*

*48-CRT*


ae26a
Let us review some of the important
characteristics of the curve showing
on the projector.
3 The cases tend to pile up in the
_____ and to be relatively
few at the extremes.
center

*49-Comment*

*The correct response is "center" or "middle." Appropriate corrective feedback would be provided for the incorrect response "mode" or "mean."*

*Several more short-answer questions follow which review the important objectives, culminating with a description of the terms, "Incomplete Beta Function" and "Normal Curve of Error."*

*Students have the option to see a frame which contains the mathematical function defining the Normal Curve of Error.*

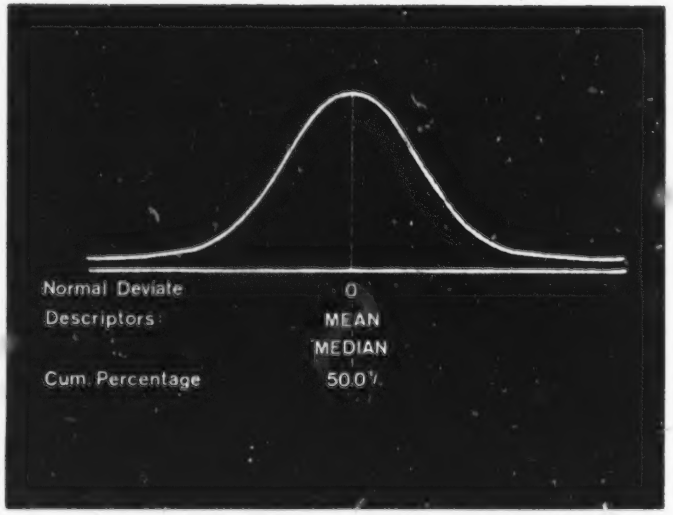
| Content Outline | Behavioral Objectives |
|---|---|
| II. Normal Curve of Error—Application | |
| A. Normal curve serves as a model for handling and describing behavior variables and characteristics of children. | Recognize model as term which best describes normal curve (multiple choice) |
| B. Center point of normal curve located at: | Recall that cumulated percentage of frequencies at center of distribution is 50 (completion) |
| 1. Arithmetic mean: sum of values in distribution divided by number of observations | Recognize symmetrical quality of model as the characteristic which makes the mean, median, and 50th percentage coincide (multiple choice) |
| 2. Median: middle value in ordered distribution of values | |
| 3. These points occur at same center point in normal curve because of its symmetrical quality | |
| C. If distribution of real data is close fit to normal curve model, relationships and locations attributed to model can be transferred to "real" data. | |

## Student Interactions

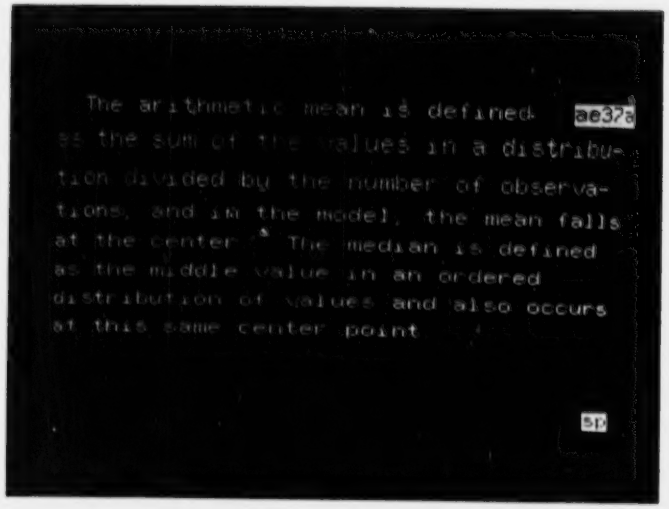
*50-Comment*

*The student is brought to criterion on the first two objectives before proceeding to the next material.*

*51-Image*



*52-CRT*


The arithmetic mean is defined as the sum of the values in a distribution divided by the number of observations, and in the model, the mean falls at the center. The median is defined as the middle value in an ordered distribution of values and also occurs at this same center point
ae37a
ST

*53-Comment*

*A light pen response is requested in 54-CRT. The correct response is the fourth option. Other options provide corrective feedback:*

*Response: First option*

*Feedback: NO. FREQUENCY CURVES HIGH ON THE ENDS AND LOW IN THE MIDDLE COULD QUALIFY. TRY AGAIN.*

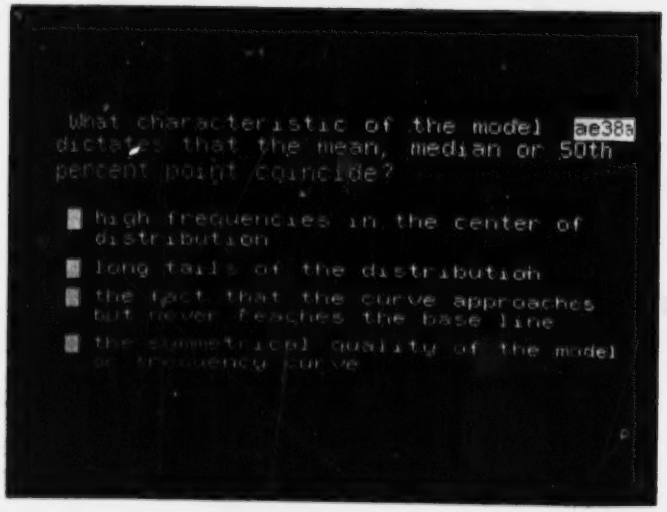
*Response: Second option*

*Feedback: FREQUENCY DISTRIBUTIONS WITHOUT TAILS COULD HAVE THE SAME CENTER POINT CHARACTERISTICS AS OUR MODEL. TRY AGAIN.*

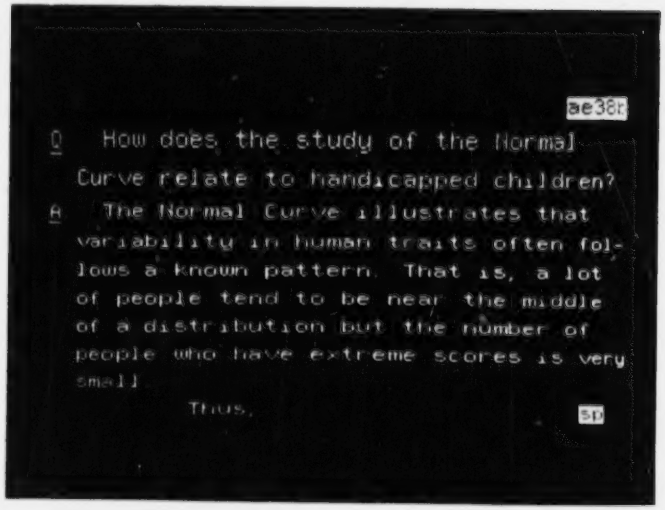
*Response: Third option*

*Feedback: NO. THIS CHARACTERISTIC WOULDN'T AFFECT THE CENTRAL TENDENCY. TRY AGAIN.*

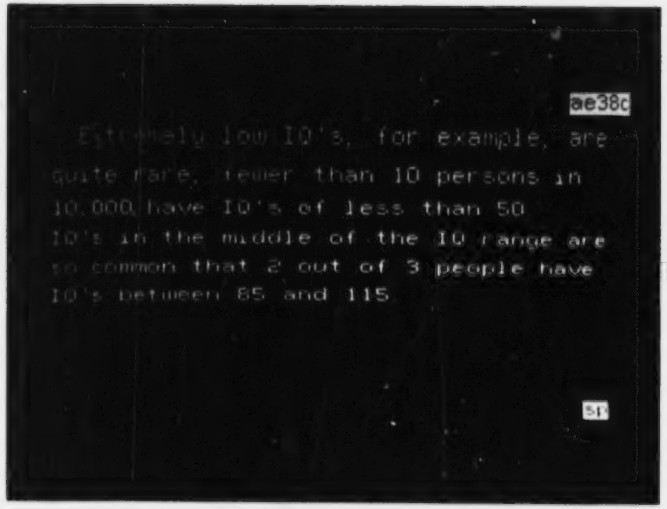
*54-CRT*


What characteristic of the model dictates that the mean, median or 50th percent point coincide?
ae38a
high frequencies in the center of distribution
long tails of the distribution
the fact that the curve approaches but never reaches the base line
the symmetrical quality of the model or frequency curve

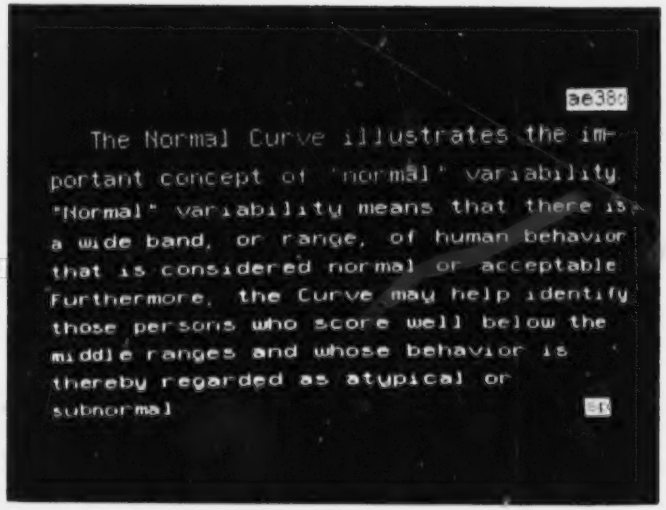
*55-CRT*


ae38b
Q How does the study of the Normal Curve relate to handicapped children?
A The Normal Curve illustrates that variability in human traits often follows a known pattern. That is, a lot of people tend to be near the middle of a distribution but the number of people who have extreme scores is very small
Thus,
ST

*56-CRT*


ae38c
Extremely low IQ's, for example, are quite rare, fewer than 10 persons in 10,000 have IQ's of less than 50. IQ's in the middle of the IQ range are so common that 2 out of 3 people have IQ's between 85 and 115.
ER

*57-CRT*


ae38c
The Normal Curve illustrates the important concept of 'normal' variability. "Normal" variability means that there is a wide band, or range, of human behavior that is considered normal or acceptable. Furthermore, the Curve may help identify those persons who score well below the middle ranges and whose behavior is thereby regarded as atypical or subnormal.
ER

Content Outline

III. Normal Deviate
   A. Standard unit of width or distance on horizontal scale or normal curve model
   B. Measures distances from center point of normal curve model; center of distribution is zero point for normal curve
      1. values above mean have positive values
      2. values below mean have negative values
   C. Distances on normal deviate scale have kind of equal and relative quality; i.e., normal deviate value of +2.0 is twice as far from the mean as normal deviate of +1.0
   D. Six normal deviates (three on each side of the mean) encompass all but .25% of the area under the curve
   E. Normal deviate is termed "standard deviation" when referring to distribution of "live" data.

Behavioral Objectives

Recognize normal deviate as being an arbitrary but uniform measure (multiple choice)

Given example, compute size of a normal deviate in score values (short answer)

Conclude that normal deviates below the mean have negative values, and normal deviates above the mean have positive values (completion)

Conclude that the area under the curve between -1$\sigma$ and 0$\sigma$ and the area between 0$\sigma$ and +1$\sigma$ are the same (alternate choice response)

Recognize symmetry as the quality that makes an area under the curve equal to a corresponding area on the other side of the median (multiple choice)

Conclude that the area between -3$\sigma$ and -1$\sigma$ is not equal to the area between -2$\sigma$ and +2$\sigma$ (alternate choice response)

Given pairs of distances on the baseline of a normal distribution, indicate whether each pair is the same or different in area (alternate choice response)

Given partially completed table of normal deviate scale points, means, and standard deviations, complete the table with equivalent values

Find mean values of a distribution of scores (short answer)

Given partially completed table of raw scores and normal deviates, complete the table with equivalent values (constructed response)

Given a distribution with a mean of 30, recognize that 22 and 38 are equidistant from the mean (multiple choice)

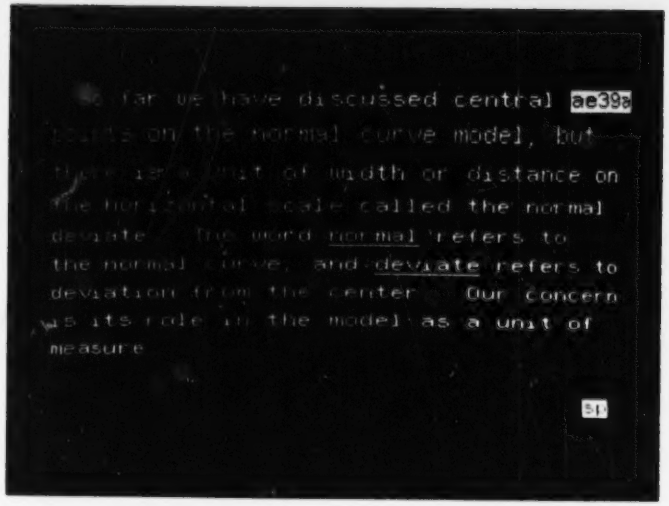
Recognize that the area between -1$\sigma$ and +1$\sigma$ includes about 2/3 of the total distribution (multiple choice)

Given spans of normal deviate values, compute the percentages of area corresponding to each span (short answer)

*58-Comment*

*51-Image is still visible to the student on the image projector and is referred to in the following interactions.*

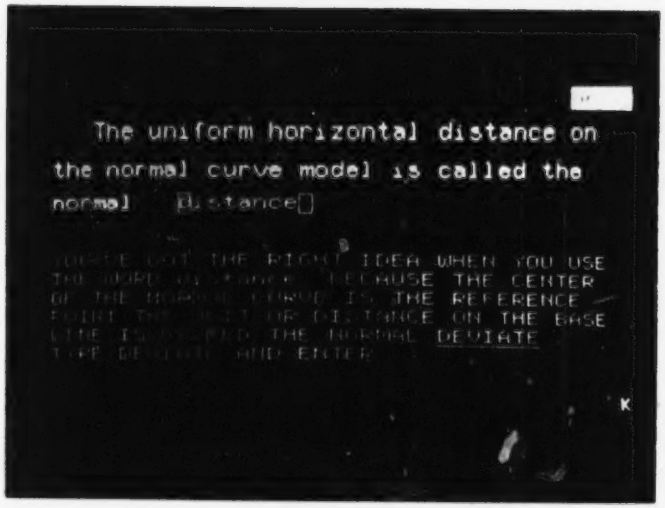
*59-CRT*


far we have discussed central ae39a
tests on the normal curve model, but
there is a unit of width or distance on
the horizontal scale called the normal
deviate. The word normal refers to
the normal curve, and deviate refers to
deviation from the center. Our concern
was its role in the model as a unit of
measure
51

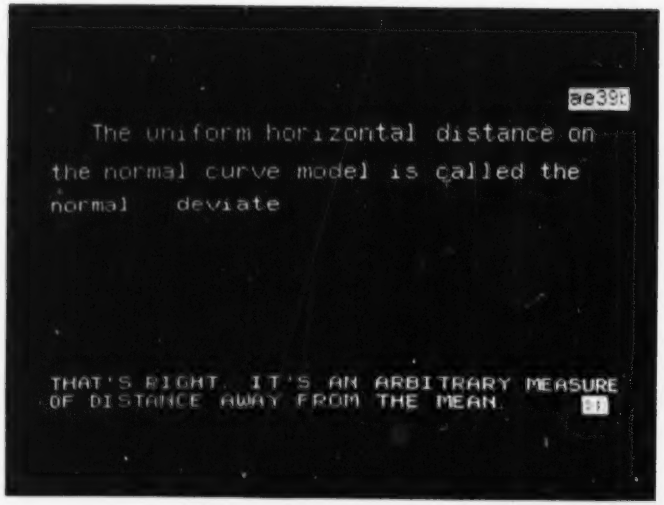
*60-Comment*

*The student responded "distance" to the question in 61-CRT and received corrective feedback. Similar interactions follow.*

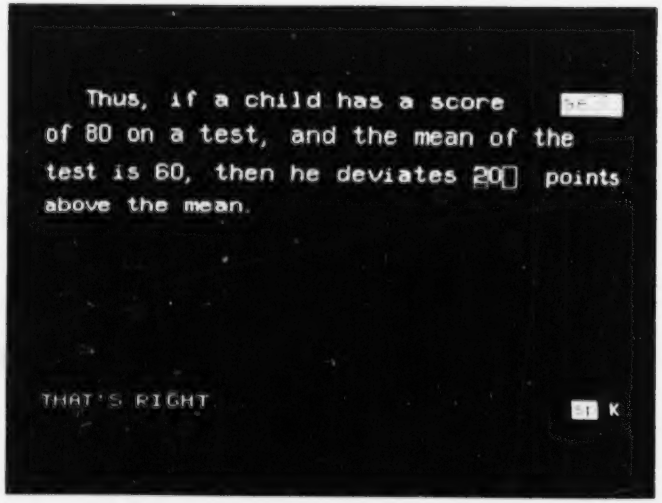
*61-CRT*



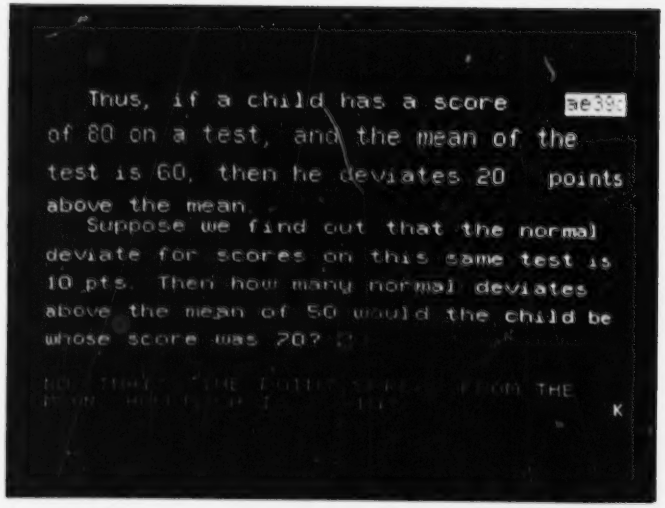
*62-CRT*


The uniform horizontal distance on the normal curve model is called the normal deviate
THAT'S RIGHT. IT'S AN ARBITRARY MEASURE OF DISTANCE AWAY FROM THE MEAN.

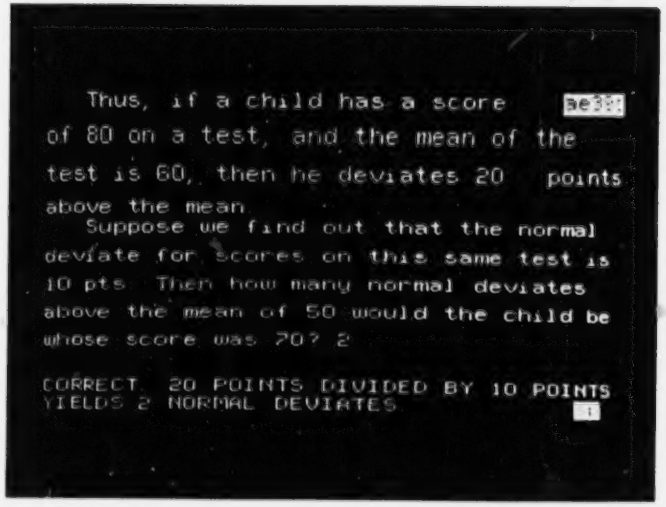
*63-CRT*


Thus, if a child has a score of 80 on a test, and the mean of the test is 60, then he deviates 20 points above the mean.
THAT'S RIGHT
K

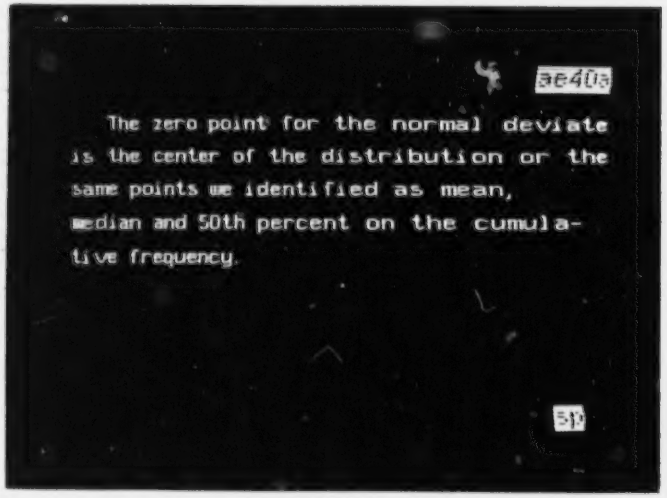
*64-CRT*


Thus, if a child has a score of 80 on a test, and the mean of the test is 60, then he deviates 20 points above the mean.
Suppose we find out that the normal deviate for scores on this same test is 10 pts. Then how many normal deviates above the mean of 50 would the child be whose score was 70?
K

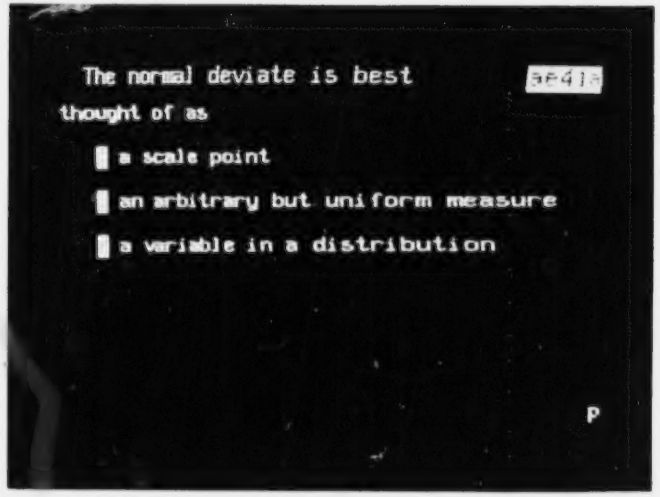
*65-CRT*


Thus, if a child has a score of 80 on a test, and the mean of the test is 60, then he deviates 20 points above the mean.
Suppose we find out that the normal deviate for scores on this same test is 10 pts. Then how many normal deviates above the mean of 50 would the child be whose score was 70? 2
CORRECT. 20 POINTS DIVIDED BY 10 POINTS YIELDS 2 NORMAL DEVIATES

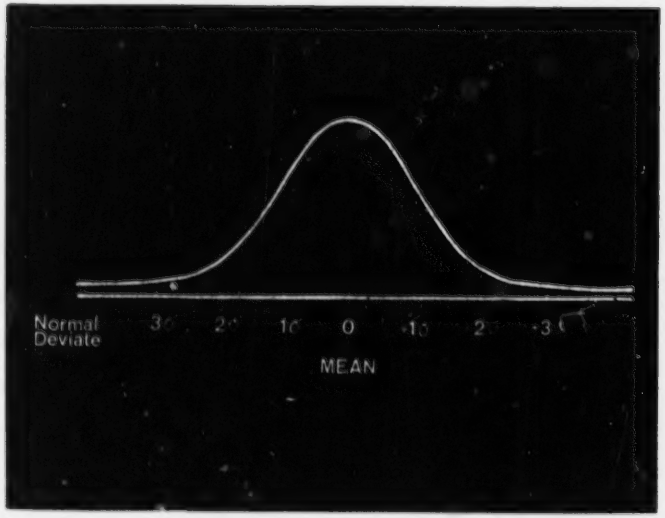
*66-CRT*


ae40
The zero point for the normal deviate is the center of the distribution or the same points we identified as mean, median and 50th percent on the cumula-tive frequency.

*67-CRT*



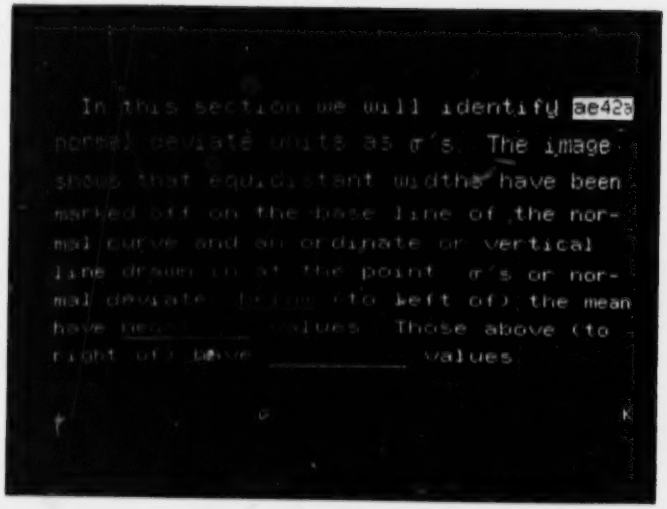

*68-Image*



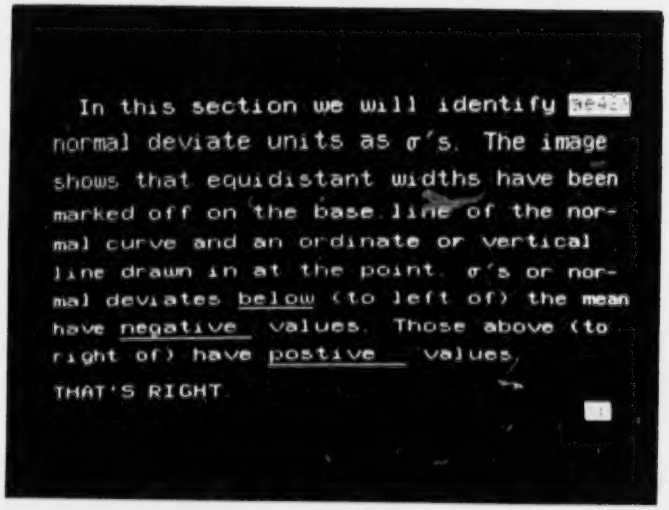

*69-Comment*

*70-CRT and 71-CRT illustrate two stages of a 3-part completion question. The student has provided each underscored word to correctly complete the sentences and to demonstrate his competency with the concepts.*

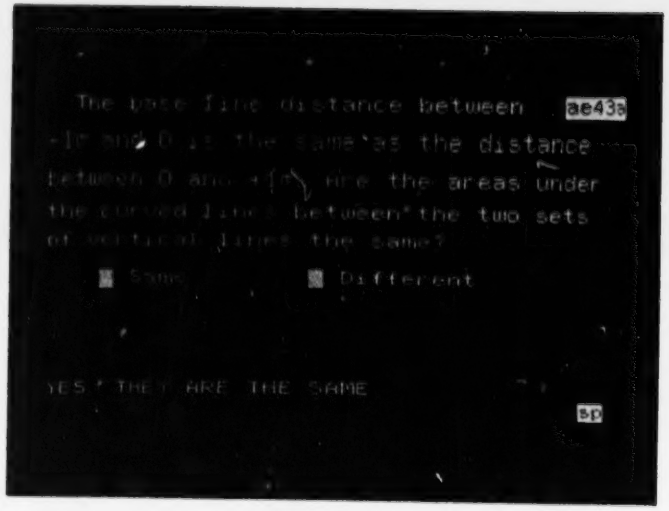
*70-CRT*


In this section we will identify ae42a
normal deviate units as σ's. The image
shows that equidistant widths have been
marked off on the base line of the nor-
mal curve and an ordinate or vertical
line drawn in at the point. σ's or nor-
mal deviates _____ (to left of) the mean
have negative values. Those above (to
right of) have _____ values.

*71-CRT*


In this section we will identify ae42a
normal deviate units as σ's. The image
shows that equidistant widths have been
marked off on the base line of the nor-
mal curve and an ordinate or vertical
line drawn in at the point. σ's or nor-
mal deviates below (to left of) the mean
have negative values. Those above (to
right of) have postive values.
THAT'S RIGHT.

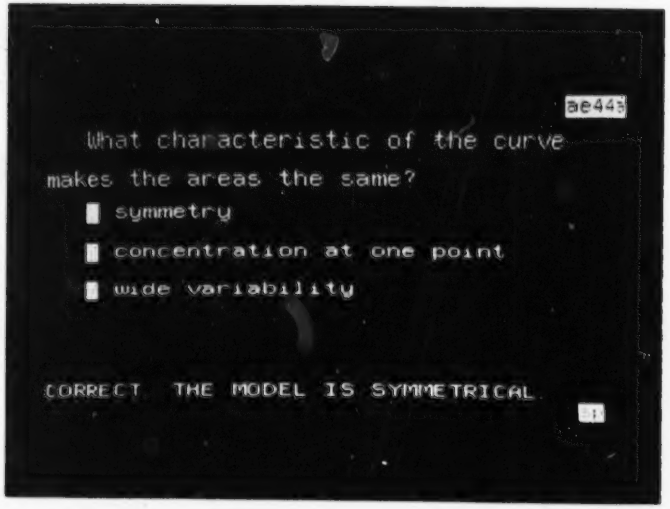
*72-CRT*


The base line distance between ae43a
-1σ and 0 is the same as the distance
between 0 and +1σ. Are the areas under
the curved lines between the two sets
of vertical lines the same?
Same
Different
YES, THEY ARE THE SAME
sp

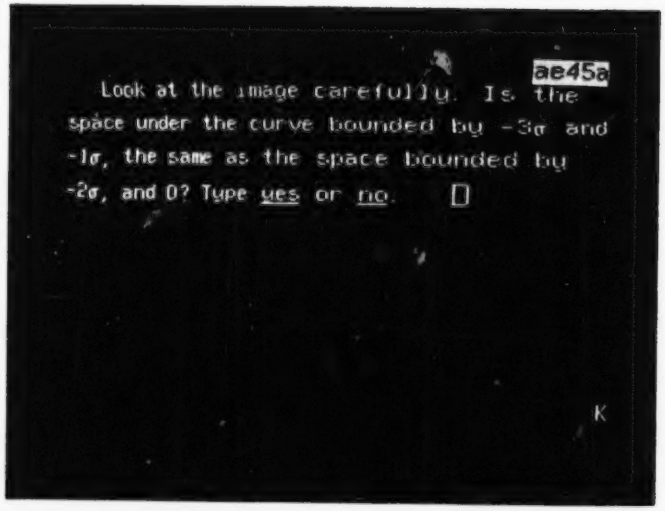
*73-Comment*

*Using the light pen the student selected "same" (72-CRT) and "symmetry" (74-CRT) as his responses and received feedback.*

*74-CRT*



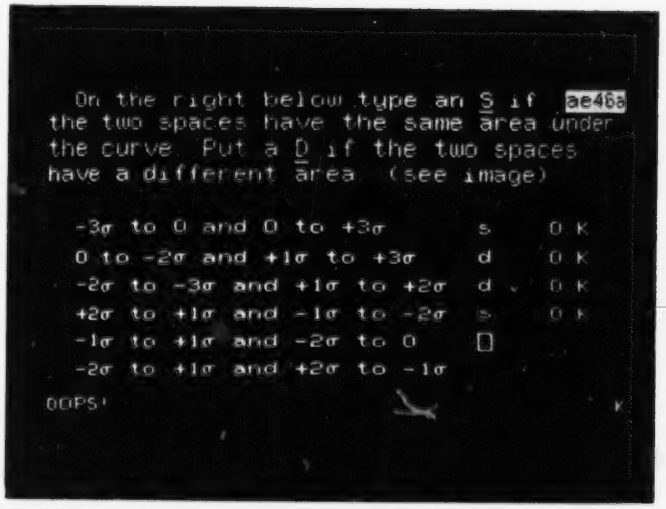

*75-CRT*


ae45a
Look at the image carefully. Is the space under the curve bounded by -3σ and -1σ, the same as the space bounded by -2σ, and 0? Type yes or no.
K

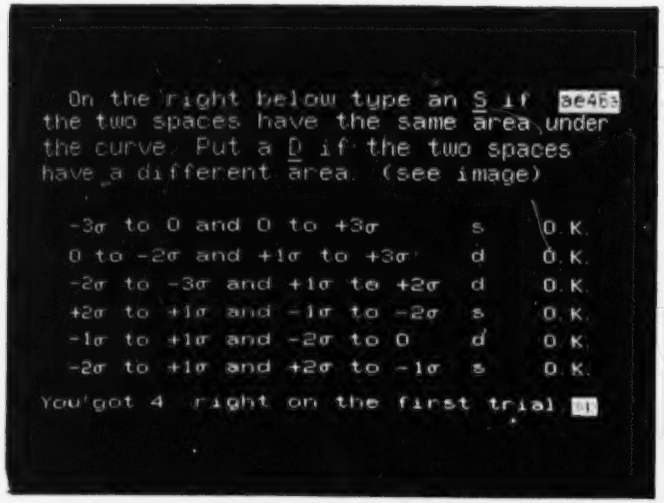
*76-Comment*

*The student has responded correctly to the first four parts of this question (77-CRT). However, he erred on the fifth, as the feedback indicates. The incorrect response was immediately erased and the student was allowed to try again.*

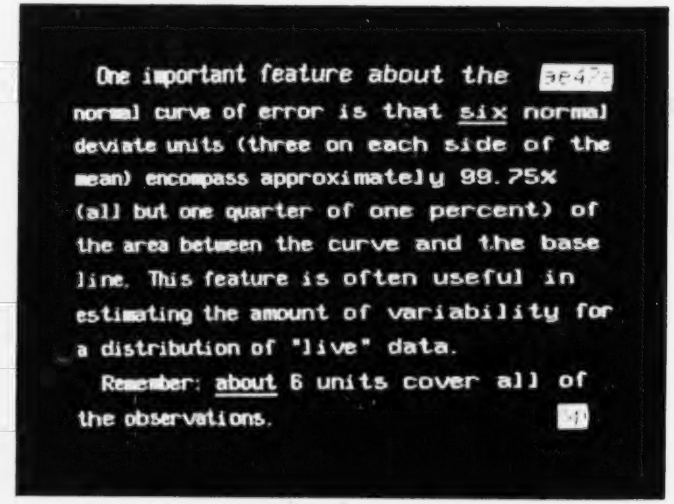
*77-CRT*


ae46a
On the right below type an S if the two spaces have the same area under the curve. Put a D if the two spaces have a different area. (see image)
-3σ to 0 and 0 to +3σ s 0 K
0 to -2σ and +1σ to +3σ d 0 K
-2σ to -3σ and +1σ to +2σ d 0 K
+2σ to +1σ and -1σ to -2σ s 0 K
-1σ to +1σ and -2σ to 0
-2σ to +1σ and +2σ to -1σ
OOPS!
K

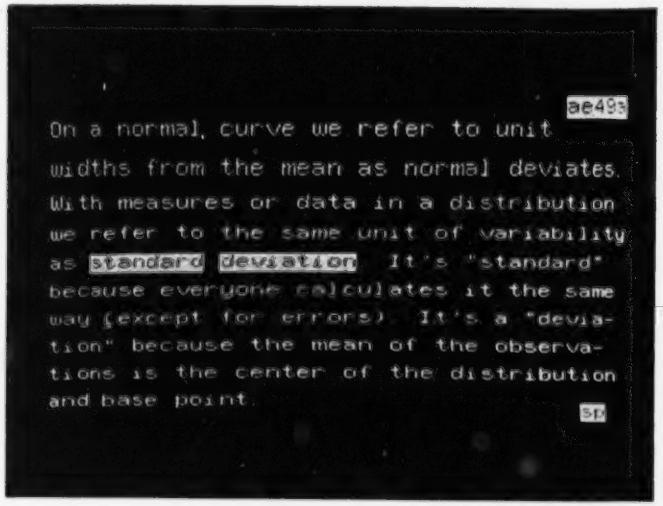
*78-CRT*


On the right below type an S if ae463
the two spaces have the same area under
the curve. Put a D if the two spaces
have a different area. (see image)
-3σ to 0 and 0 to +3σ s O.K.
0 to -2σ and +1σ to +3σ d O.K.
-2σ to -3σ and +1σ to +2σ d O.K.
+2σ to +1σ and -1σ to -2σ s O.K.
-1σ to +1σ and -2σ to 0 d O.K.
-2σ to +1σ and +2σ to -1σ s O.K.
You got 4 right on the first trial

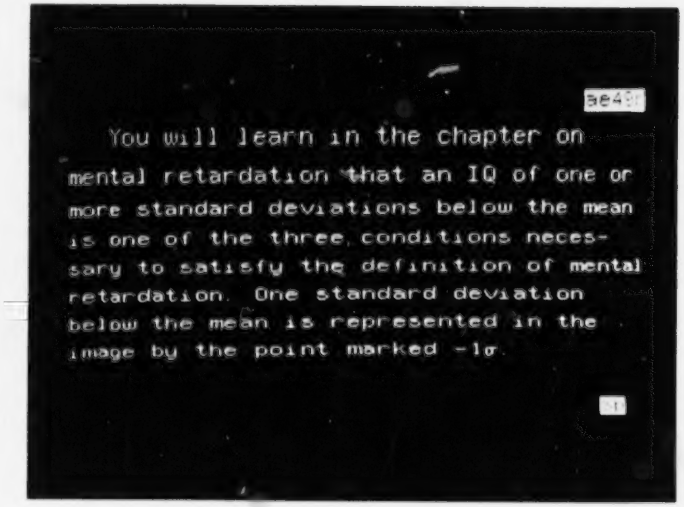
*79-CRT*


One important feature about the ae47
normal curve of error is that six normal
deviate units (three on each side of the
mean) encompass approximately 99.75%
(all but one quarter of one percent) of
the area between the curve and the base
line. This feature is often useful in
estimating the amount of variability for
a distribution of "live" data.
Remember: about 6 units cover all of
the observations.

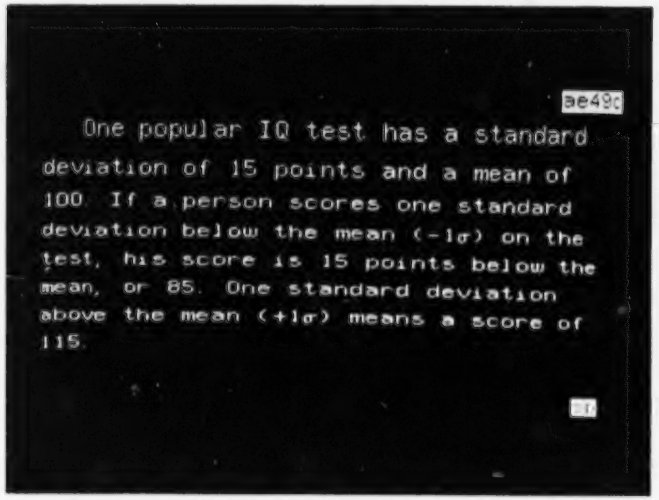
*80-CRT*


ae493
On a normal curve we refer to unit
widths from the mean as normal deviates.
With measures or data in a distribution
we refer to the same unit of variability
as standard deviation. It's "standard"
because everyone calculates it the same
way (except for errors). It's a "devia-
tion" because the mean of the observa-
tions is the center of the distribution
and base point.

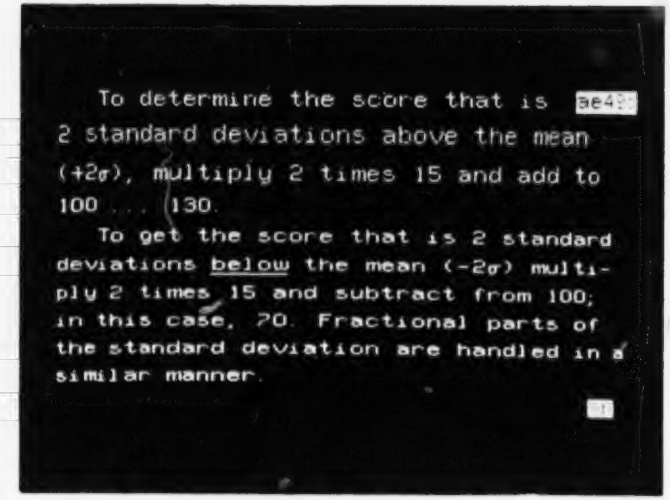
*81-CRT*


ae49
You will learn in the chapter on
mental retardation that an IQ of one or
more standard deviations below the mean
is one of the three conditions neces-
sary to satisfy the definition of mental
retardation. One standard deviation
below the mean is represented in the
image by the point marked -1σ.

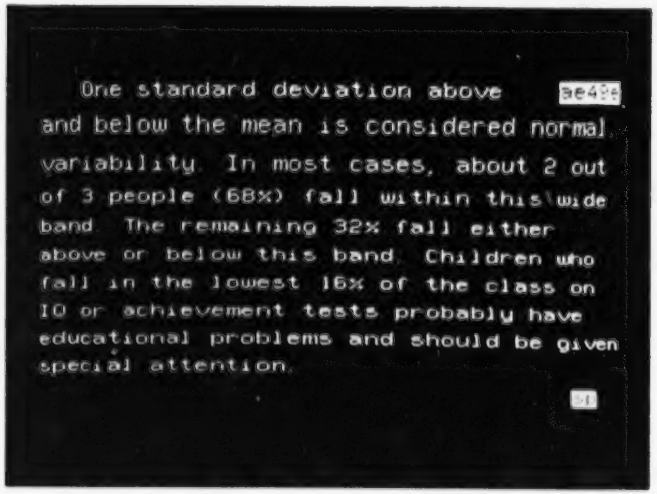
*82-CRT*


One popular IQ test has a standard deviation of 15 points and a mean of 100. If a person scores one standard deviation below the mean (-1σ) on the test, his score is 15 points below the mean, or 85. One standard deviation above the mean (+1σ) means a score of 115.

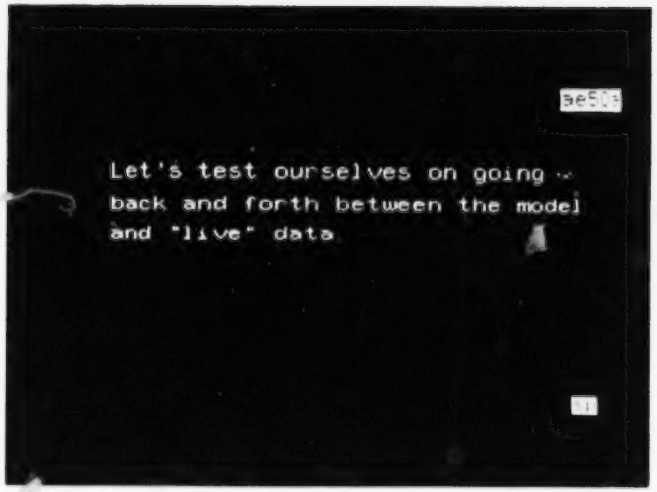
*83-CRT*


To determine the score that is 2 standard deviations above the mean (+2σ), multiply 2 times 15 and add to 100 . . . 130.
To get the score that is 2 standard deviations below the mean (-2σ) multiply 2 times 15 and subtract from 100; in this case, 70. Fractional parts of the standard deviation are handled in a similar manner.

*84-CRT*


One standard deviation above and below the mean is considered normal variability. In most cases, about 2 out of 3 people (68%) fall within this wide band. The remaining 32% fall either above or below this band. Children who fall in the lowest 16% of the class on IQ or achievement tests probably have educational problems and should be given special attention.

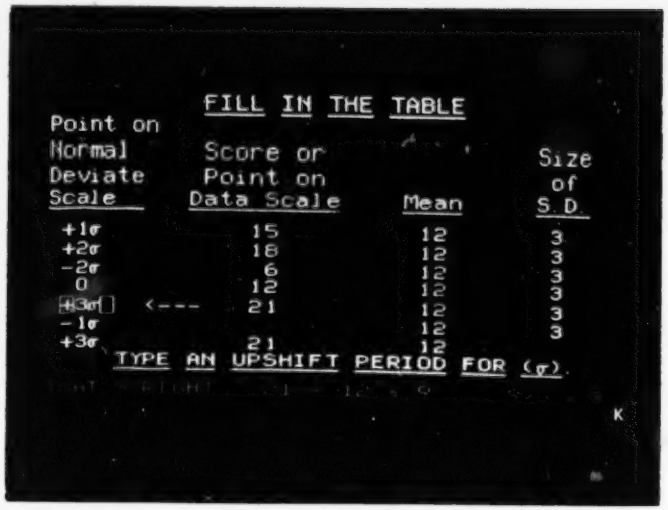
*85-CRT*



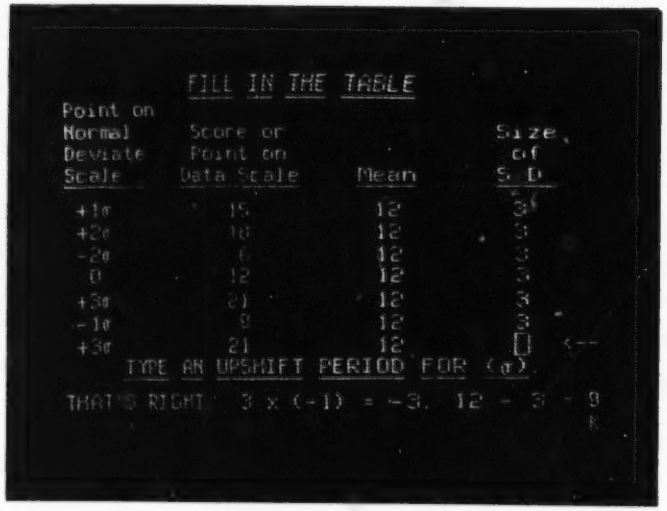
*86-Comment*

*87-CRT and 88-CRT illustrate two stages of a three part completion question requiring the student to demonstrate his competency with certain concepts of normal deviates.*

*87-CRT*


FILL IN THE TABLE
Point on Normal Deviate Scale
Score or Point on Data Scale
Mean
Size of S.D.
+1σ 15 12 3
+2σ 18 12 3
-2σ 6 12 3
0 12 12 3
+3σ [] <--- 21 12 3
-1σ 12 3
+3σ 21 12
TYPE AN UPSHIFT PERIOD FOR (σ).

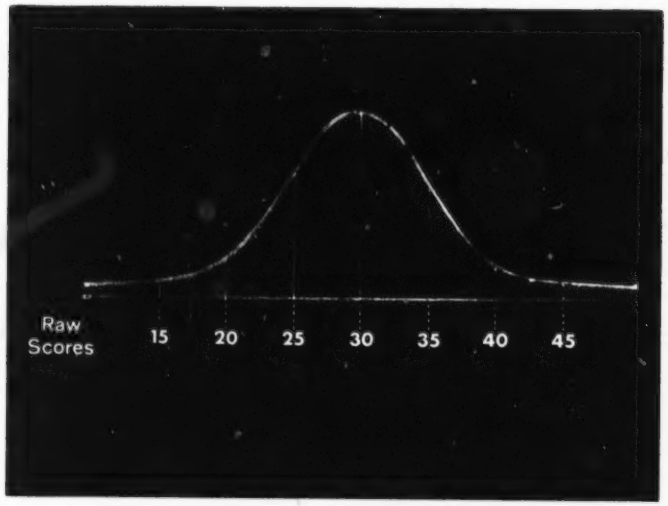
*88-CRT*


FILL IN THE TABLE
Point on Normal Deviate Scale
Score or Point on Data Scale
Mean
Size of S.D.
+1σ 15 12 3
+2σ 18 12 3
-2σ 6 12 3
0 12 12 3
+3σ 21 12 3
-1σ 9 12 3
+3σ 21 12 [] <--
TYPE AN UPSHIFT PERIOD FOR (σ).
THAT'S RIGHT. 3 x (-1) = -3. 12 - 3 = 9

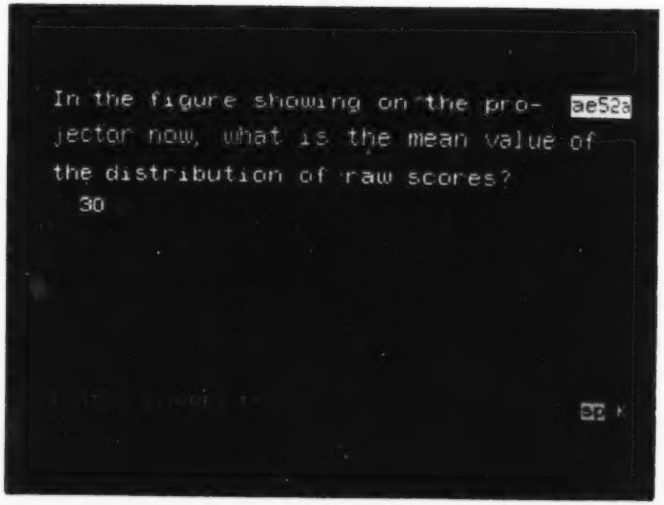
*89-Comment*

*91-CRT through 95-CRT refer the student to 90-Image. Each student response causes the program to provide proper feedback—supportive for correct responses and remedial, corrective feedback for incorrect responses.*

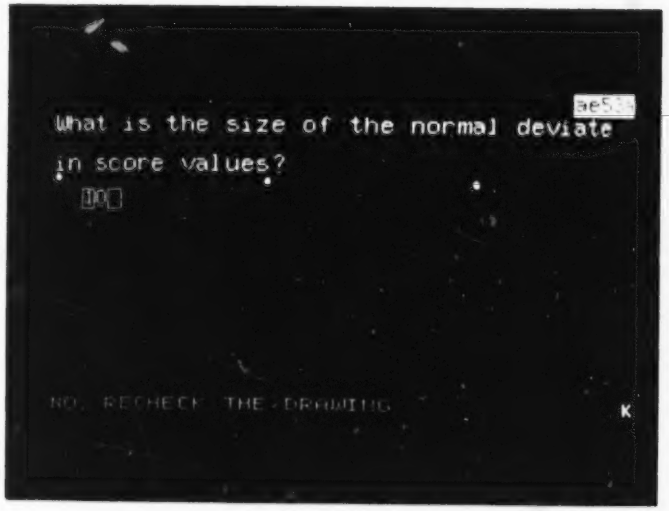
*90-Image*



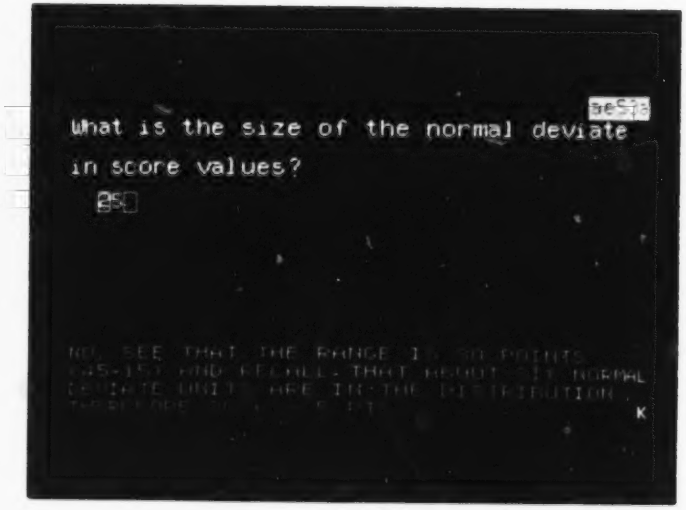

*91-CRT*



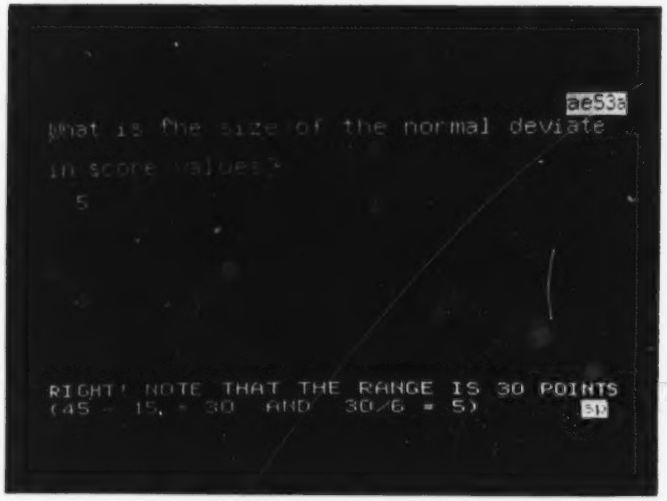

*92-CRT*



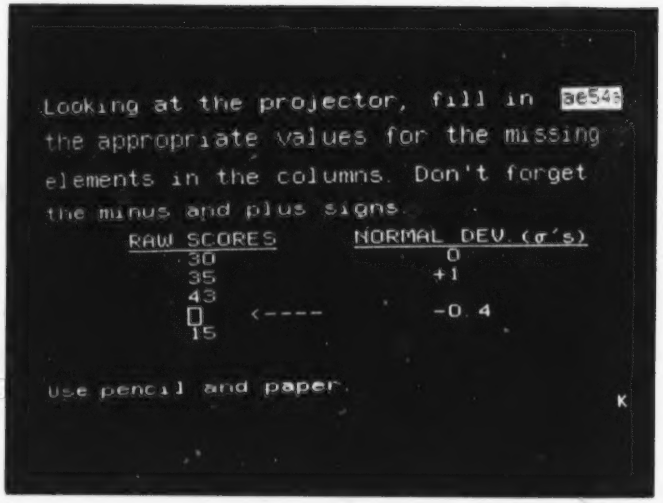

*93-CRT*



*94-CRT*




*95-CRT*




*96-Comment*

*The correct response is "28" (95-CRT). Following is an illustration of incorrect responses and the associated feedback for each:*

*Response: 32*

*Feedback: NOPE, YOU FORGOT TO PAY ATTENTION TO THE MINUS SIGN.*

*Response: 26*

*Feedback: YOU MAY HAVE FORGOTTEN THAT 4/10 OF 5 IS ONLY 2, NOT 4. TRY AGAIN.*

*Response: First unrecognized or unanticipated response*

*Feedback: HINT: IF 4/10 OF 10 = 4, THEN 4/10 OF 5 = 2.*

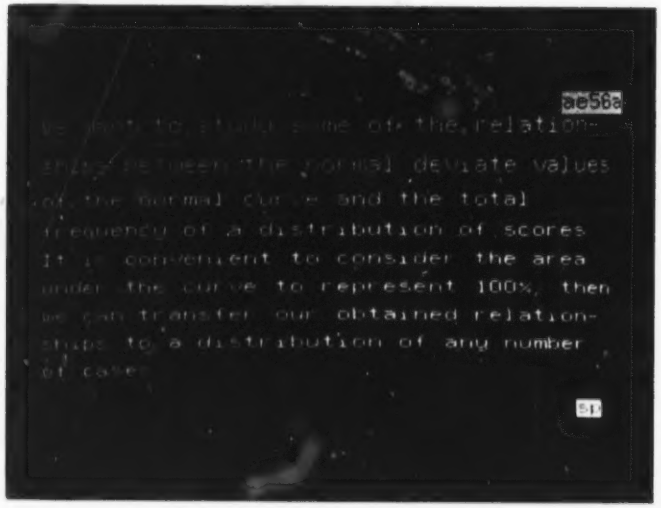
*Response: Second unrecognized or unanticipated response*

*Feedback: HINT: IF 4/10 OF 5, THE NORMAL DEVIATE VALUE IS 2 SCORE POINTS, AND IF THE MINUS SIGN SAYS TO SUBTRACT IT FROM THE MEAN, WHAT IS 30 – 2?*

*Response: Third unrecognized or unanticipated response*

*Feedback: THE MEAN IS 30 AND 0.4σ BELOW THE MEAN IS 2 SCORE POINTS. 30 – 2 = 28. ENTER 28.*

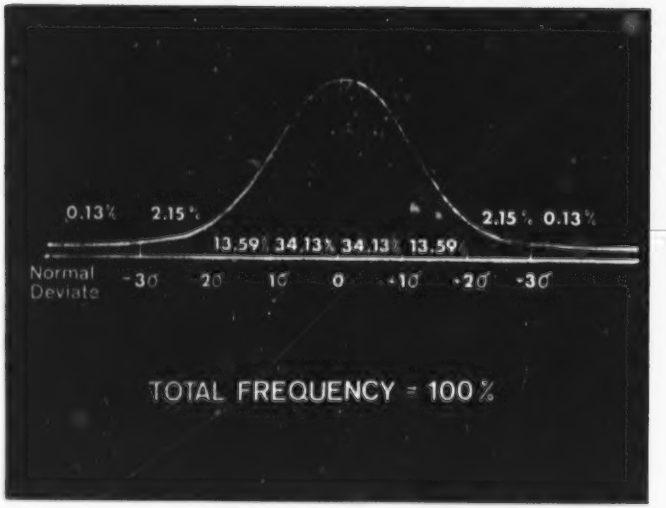
*97-CRT*



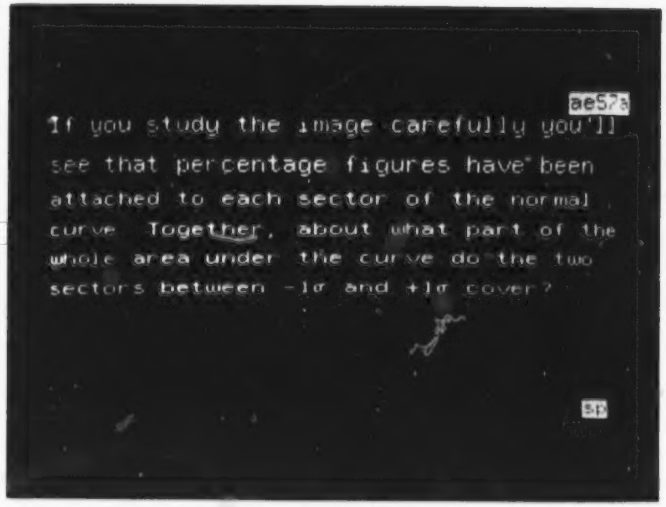

*98-Comment*

*100-CRT, 101-CRT, and 103-CRT refer to 99-Image.*

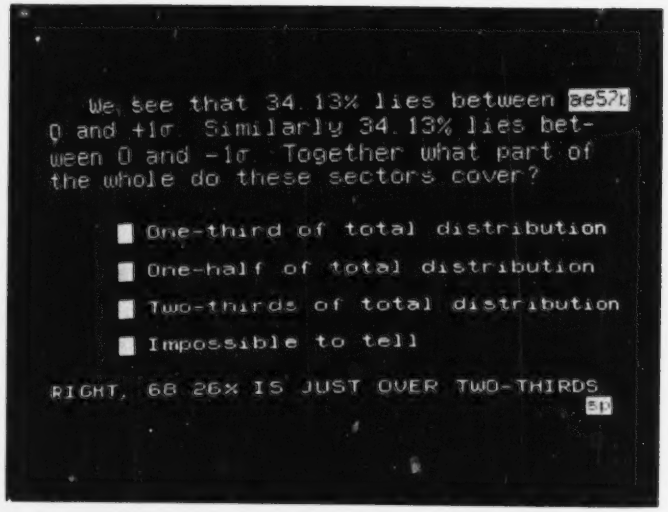
*99-Image*



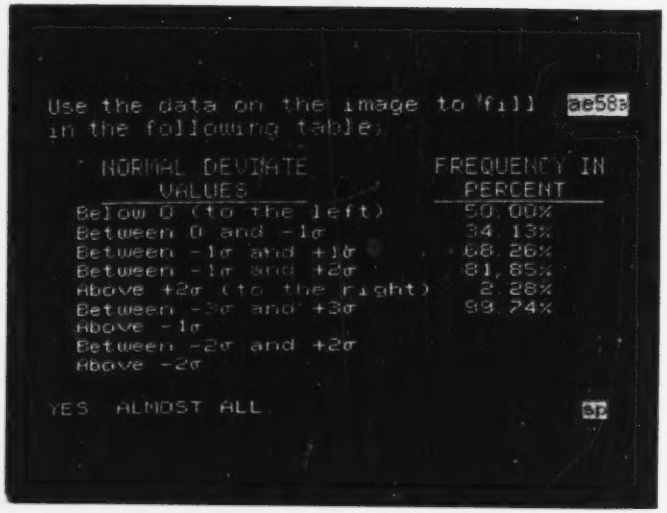

*100-CRT*


ae57a
If you study the image carefully you'll see that percentage figures have been attached to each sector of the normal curve. Together, about what part of the whole area under the curve do the two sectors between -1σ and +1σ cover?
ST

*101-CRT*


We see that 34.13% lies between
0 and +1σ. Similarly 34.13% lies between 0 and -1σ. Together what part of the whole do these sectors cover?
One-third of total distribution
One-half of total distribution
Two-thirds of total distribution
Impossible to tell
RIGHT, 68.26% IS JUST OVER TWO-THIRDS

*103-CRT*


Use the data on the image to fill in the following table:
NORMAL DEVIATE VALUES
FREQUENCY IN PERCENT
Below 0 (to the left) 50.00%
Between 0 and -1σ 34.13%
Between -1σ and +1σ 68.26%
Between -1σ and +2σ 81.85%
Above +2σ (to the right) 2.28%
Between -3σ and +3σ 99.74%
Above -1σ
Between -2σ and +2σ
Above -2σ
YES, ALMOST ALL.

*102-Comment*

*103-CRT shows that the student has responded correctly to the first six problems. Following is an illustration of incorrect responses and the associated feedback for the sixth problem:*

*Response: 100%*

*Feedback: THE ANSWER COULD NOT BE 100 UNLESS WE INCLUDED ALL SEGMENTS. TRY AGAIN.*

*Response: 99.94%, 99.84%, 99.64%, 99.24%, or 99.75%*

*Feedback: YOU'RE VERY CLOSE. BETTER CHECK YOUR ARITHMETIC.*

*Response: 4.56%*

*Feedback: YOU'VE INCLUDED SEGMENTS ABOVE +2σ AND BELOW -2σ AND SUMMED THE FREQUENCIES. TRY AGAIN.*

*Response: 84.13%*

*Feedback: NO. YOU ADDED PROPORTIONAL FREQUENCIES EITHER BELOW +2σ OR ABOVE -2σ.*

*Remedial, tutorial instruction is provided as feedback for unanticipated and unrecognized responses.*

Content Outline

IV. Normal Curve Table
   A. Convert areas to percentages by moving the decimal point two places to the right and adding a percent sign.
   B. Column 2 of the table gives the area from the mean to the normal deviate value.
   C. Column 3 of the table gives the area under the larger portion of the curve either above or below the normal deviate.
   D. Column 4 gives the area under the smaller portion of the curve either above or below the normal deviate.

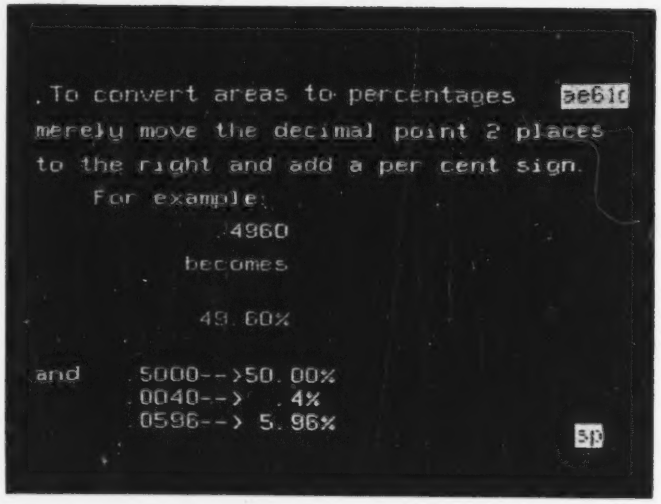
Behavioral Objectives

Given a table of Areas of Normal Curve, be able to interpret the table and use it to convert normal deviates to areas and areas to normal deviates (constructed responses)

Recognize that the areas under the normal curve can be thought of as percentages of the total frequency or area (constructed responses)

Student Interactions

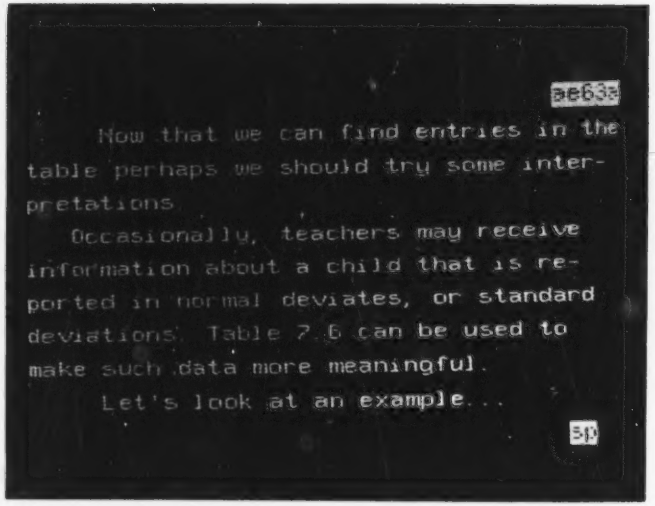
*104-CRT*




*105-Comment*

*106-CRT refers the student to Plate 7.6 in the student reference handbook which accompanies the course. The table is included in this documentation inside the back cover.*

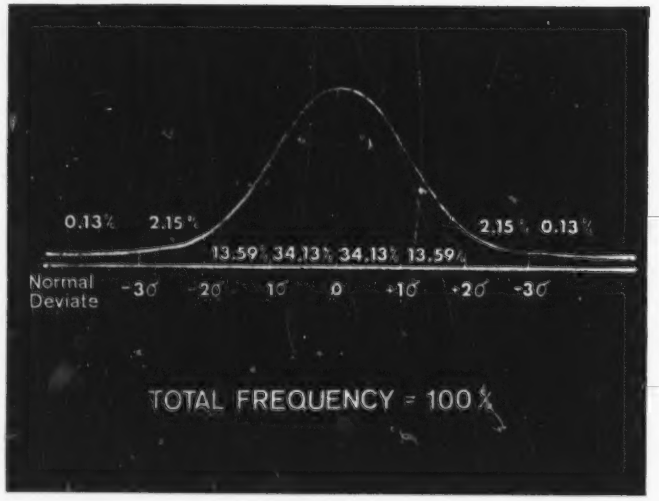
*106-CRT*


ae63#
Now that we can find entries in the table perhaps we should try some interpretations.
Occasionally, teachers may receive information about a child that is reported in normal deviates, or standard deviations. Table 7.6 can be used to make such data more meaningful.
Let's look at an example...
SP

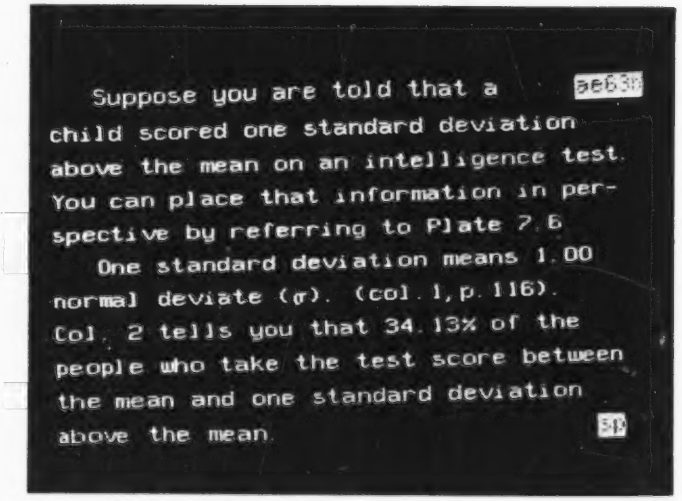
*107-Comment*

*The relationship of tabular and graphic representation of the areas of the normal curve are developed through the coordinated use of the CRT for explanations, image projector for graphic displays, and the table for tabular data.*

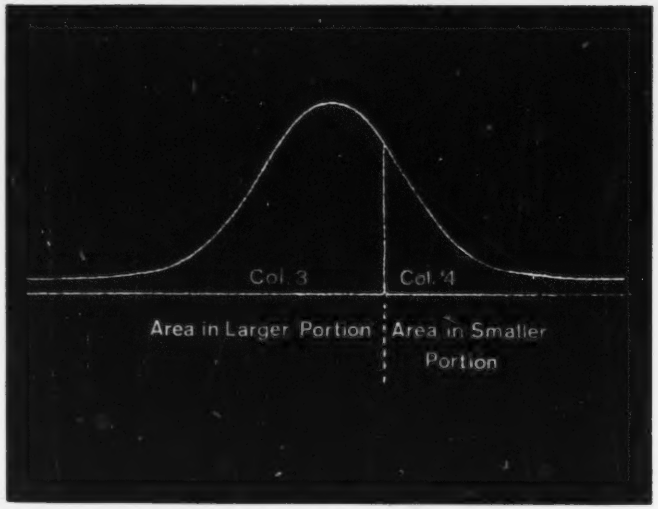
*108-Image*




*109-CRT*


ae63#
Suppose you are told that a child scored one standard deviation above the mean on an intelligence test. You can place that information in perspective by referring to Plate 7.6
One standard deviation means 1.00 normal deviate (σ). (col. 1, p. 116). Col. 2 tells you that 34.13% of the people who take the test score between the mean and one standard deviation above the mean.
SP

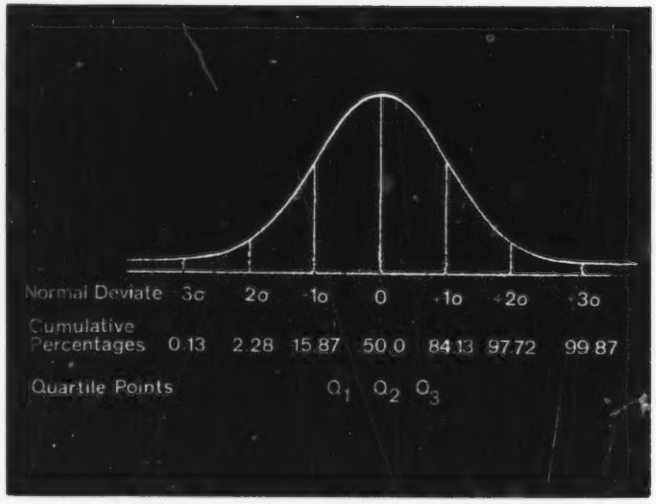
*110-Image*




*111-CRT*

Since the child scored above the mean we will use col. 3 to find the percentage of the population that he surpassed. Col. 3 indicates that the child scored higher than 84.13% of the general population (theoretically). Col. 4 indicates the theoretical percentage of people who score higher than him (15.87%). If the child had scored below the mean, we would reverse cols. 3 & 4.

*112-Image*

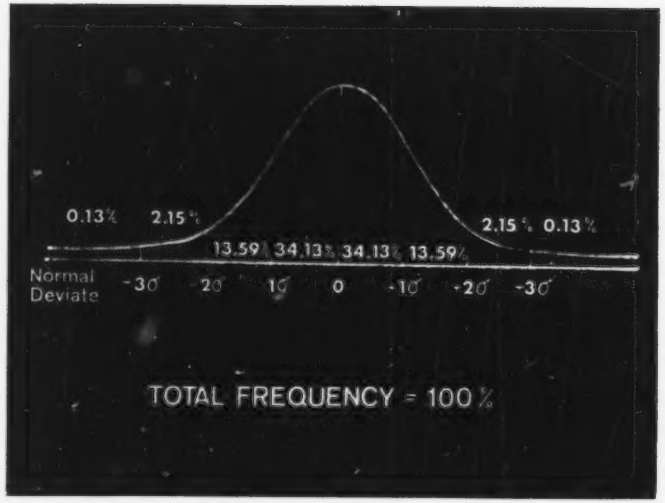



*113-CRT*

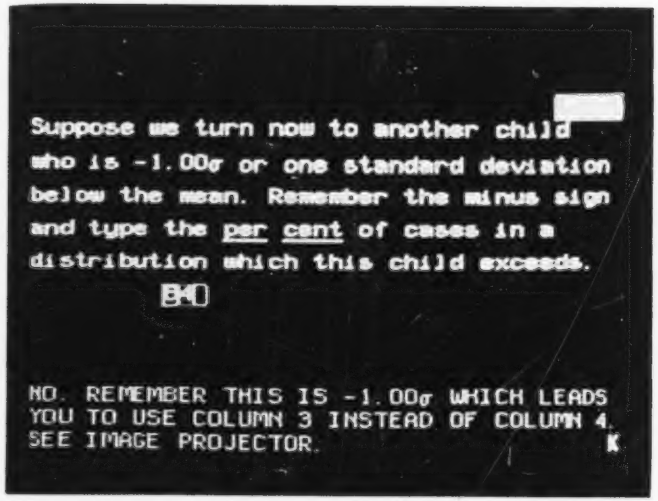
The image shows the cumulative percentages for several points on the curve.

In effect, Table 7.6 fills in the gaps between the Normal Deviate points shown.

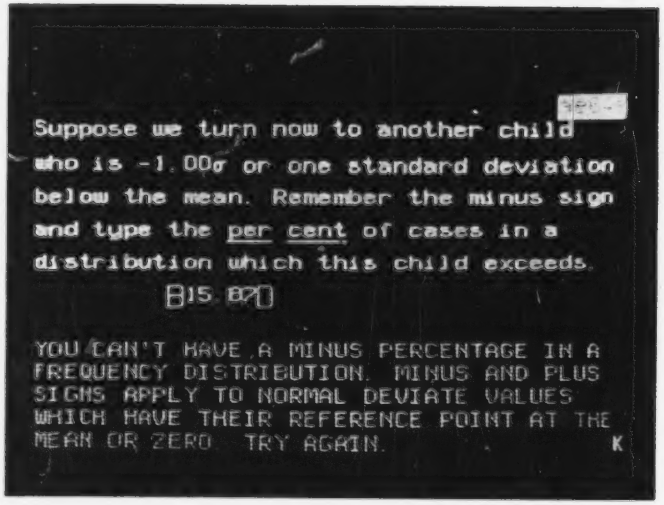
*114-Image*



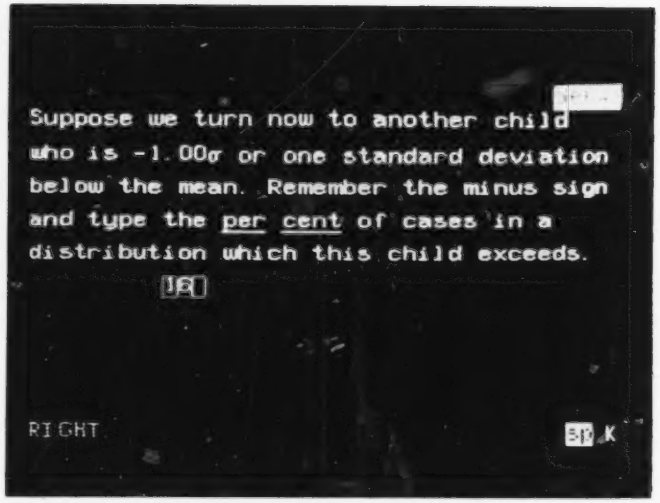

*115-CRT*


Suppose we turn now to another child who is -1.00σ or one standard deviation below the mean. Remember the minus sign and type the per cent of cases in a distribution which this child exceeds.
B40
NO. REMEMBER THIS IS -1.00σ WHICH LEADS YOU TO USE COLUMN 3 INSTEAD OF COLUMN 4. SEE IMAGE PROJECTOR.
K

*116-CRT*


Suppose we turn now to another child who is -1.00σ or one standard deviation below the mean. Remember the minus sign and type the per cent of cases in a distribution which this child exceeds.
B15 B7
YOU CAN'T HAVE A MINUS PERCENTAGE IN A FREQUENCY DISTRIBUTION. MINUS AND PLUS SIGNS APPLY TO NORMAL DEVIATE VALUES WHICH HAVE THEIR REFERENCE POINT AT THE MEAN OR ZERO. TRY AGAIN.
K

*117-CRT*


Suppose we turn now to another child who is -1.00σ or one standard deviation below the mean. Remember the minus sign and type the per cent of cases in a distribution which this child exceeds.
B16
RIGHT.
K

Content Outline

V. Measures of Relative Position
   A. Percentiles: divide distributions into 100 equal parts
      1. 50th percentile corresponds to normal deviate of 0
      2. 84th percentile corresponds to normal deviate of +1.0
   B. Quartiles: divide distributions into four equal parts
   C. Deciles: divide distributions into ten equal parts
   D. Quintiles: divide distributions into five equal parts
   E. Equal and relative quality are not associated with standard deviations

Behavioral Objectives

Conclude that quintiles represent five equal parts (short answer)

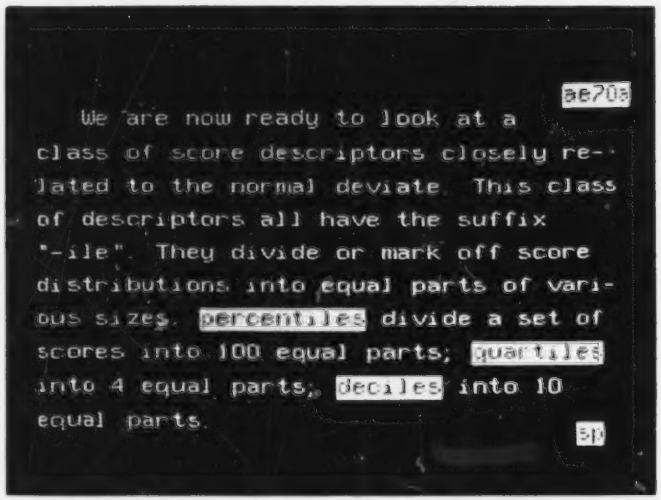
Given a partially completed table with percentiles, deciles, and quartiles, complete the table with the appropriate equivalent values (short answer)

Identify 84th PR as the PR corresponding to a normal deviate value of +1 (short answer)

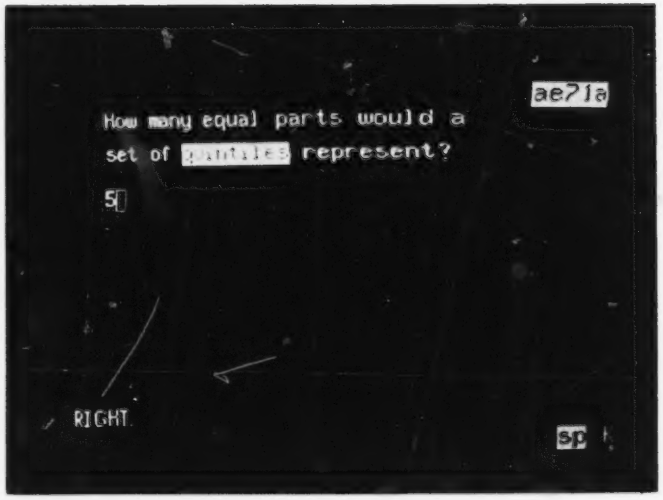
Given percentile ranks, determine the normal deviate values that correspond to each (short answer)

Student Interactions

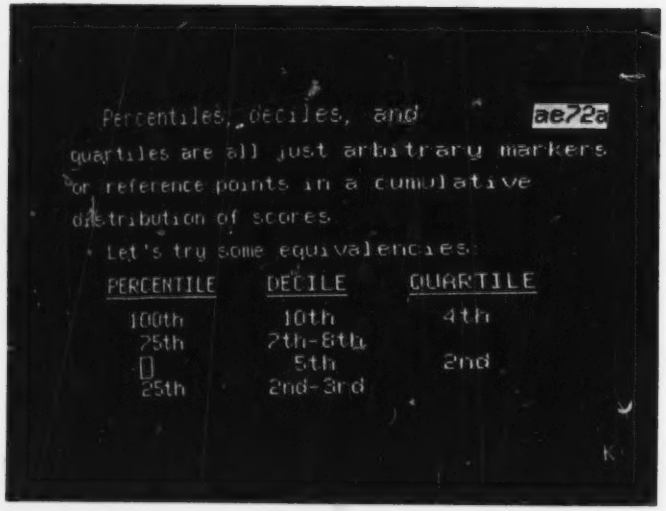
*118-CRT*


ae?0a
We are now ready to look at a class of score descriptors closely re-lated to the normal deviate. This class of descriptors all have the suffix "-ile". They divide or mark off score distributions into equal parts of vari-ous sizes. percentiles divide a set of scores into 100 equal parts; quartiles into 4 equal parts; deciles into 10 equal parts.
SP

*119-CRT*



*120-CRT*




*121-Comment*

*A series of exercises (not shown here) require the student to convert percentiles, quartiles, and deciles from one to another. He must convert the following:*

*3rd quartile to 75th percentile and 7-8th decile*
*50th percentile to 5th decile and 2nd quartile*
*1st quartile to 25th percentile and 2nd-3rd decile*

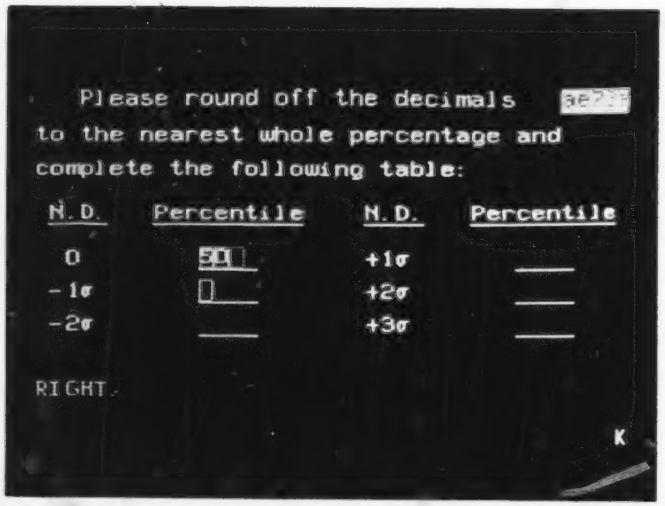
*122-Audio*

**In using percentiles and quartiles to describe the relative position of pupils in some meaningful group, a pupil's score may be said to be at the 75th percentile or at the third quartile. It is incorrect to say that a pupil's score is in the third quartile. Because the quartiles are just score markers or points, a pupil's score cannot be in them. Many people make the mistake of confusing quartiles with quarters. It is, of course, permissible to refer to a given score as being in the third quarter of the distribution, but such a score will be below the third and above the second quartile or median.**

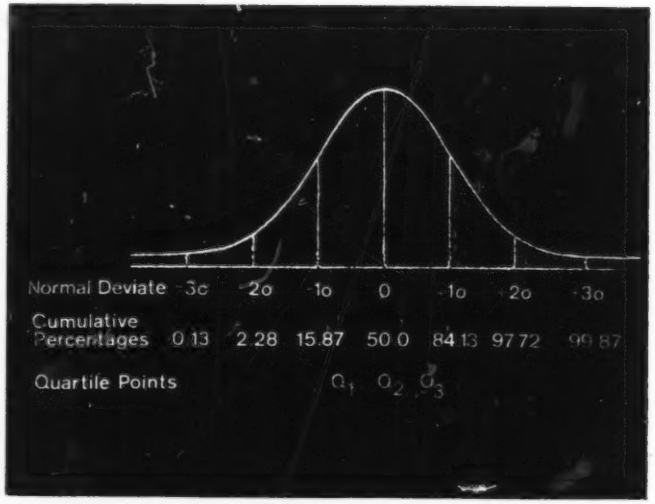
*123-Comment*

*124-CRT refers the student to 125-Image for solving the problems. The student responded correctly to the first problem, received feedback and is ready to respond to the second problem (124-CRT).*

*124-CRT*



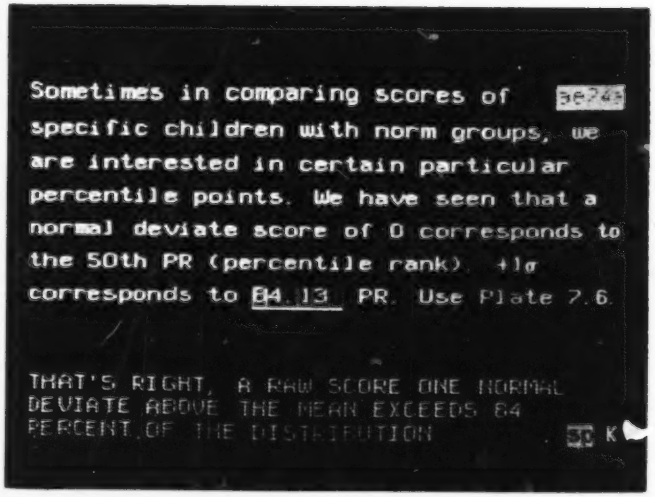

*125-Image*




*126-Comment*

*127-CRT shows that the student responded correctly with "84.13" and received feedback.*

*127-CRT*


Sometimes in comparing scores of
specific children with norm groups, we
are interested in certain particular
percentile points. We have seen that a
normal deviate score of 0 corresponds to
the 50th PR (percentile rank). +1σ
corresponds to 84.13 PR. Use Plate 7.6.
THAT'S RIGHT, A RAW SCORE ONE NORMAL
DEVIATE ABOVE THE MEAN EXCEEDS 84
PERCENT OF THE DISTRIBUTION
K

*128-Audio*

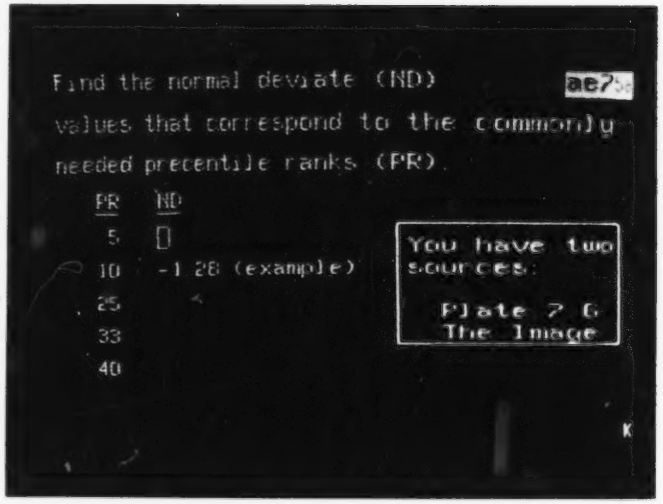
**Now we want to learn how to convert percentile ranks (PR) in normally distributed data into their corresponding normal deviate values. Notice on the screen that we've chosen percentile rank 10 (that is PR 10) as an example. To find the corresponding normal deviate we first decide if the 10th percentile rank is above or below the mean. If it is above the mean, our corresponding normal deviate will have a plus sign; if below, the normal deviate will be minus. This decision also tells us which column of the table to use. Values in Column 3 begin at 50 percent and go up to 100 percent; consequently, they represent frequencies in the larger portion of a divided curve. Values in Column 4 begin at 50 percent and go down; consequently, they represent values in the smaller portions of a divided curve. Since 10 is below 50, the value we seek in the table will have a minus sign. And, we can locate it by looking for .10 in Column 4. Do this now.**

**In Column 4 on Page 4 of the table you will notice that the value closest to .10 is .1003. Read across to your left in the first column and you will find the normal deviate value of 1.28. We remembered the minus sign and entered -1.28 as our answer. Now you can try some table look-ups.**

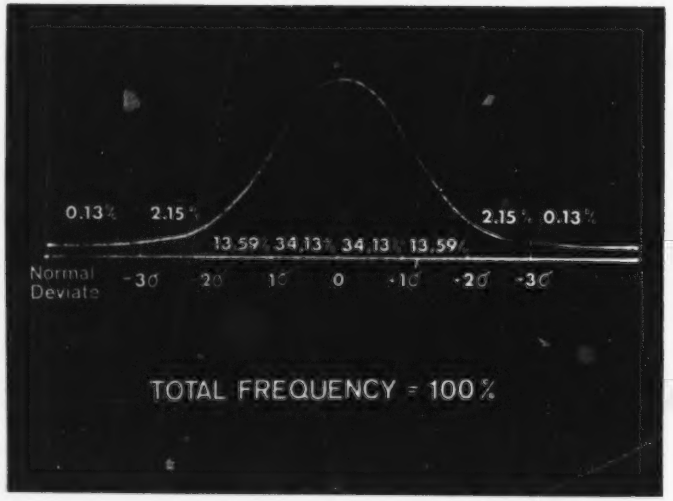
*129-Comment*

*The student is shown the example (130-CRT) just presented by audio and is required to perform four table look-ups. 132-CRT shows that the student responded incorrectly to the first problem, received feedback, and is asked to try again. If he continues to do poorly on this exercise, he is presented with more problems of the same type before proceeding with the program.*

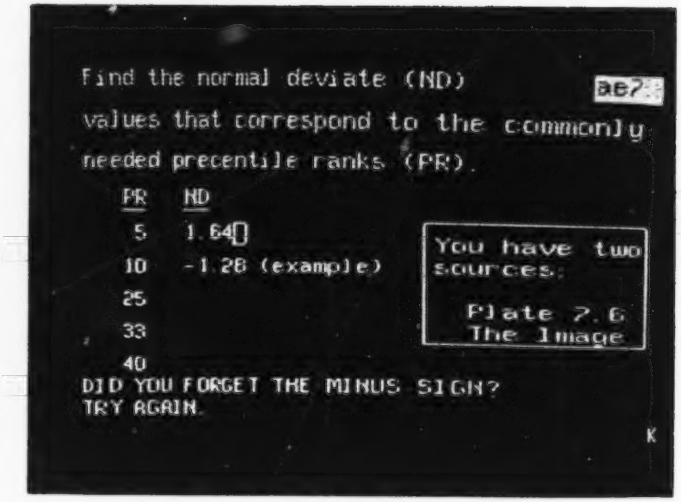
*130-CRT*



*131-Image*




*132-CRT*



Content Outline

VI. Derived Scores
  A. T-scores
    1. distribution has a mean of 50 and a standard deviation of 10
    2. alleviates awkwardness of negative values and decimals associated with normal deviates
    3. percentile ranks can be converted into T-scores

Behavioral Objectives

Given normal deviate values, determine PR equivalent for each (short answer)
Given T-score values, determine PR equivalent for each (short answer)

Student Interactions

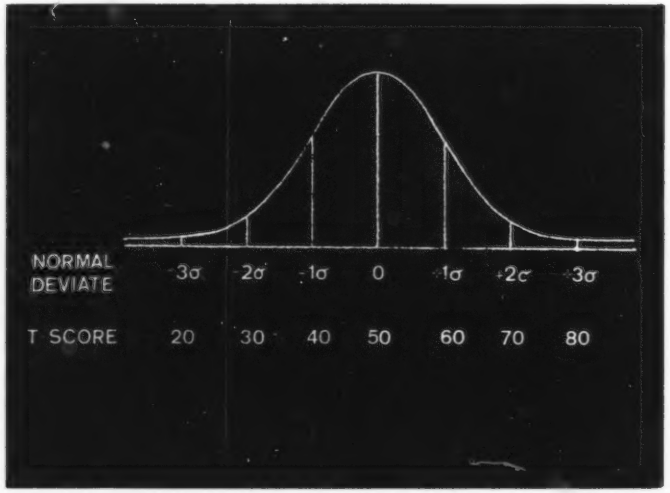
*133-Audio*

**In the early days of educational measurement, teachers and other practitioners objected to the use of normal deviate scores for describing pupil test performances. They particularly didn't like the decimals and the necessity for keeping positive and negative signs straight. To overcome this hurdle, Ben Wood proposed a new type of standard score which he called T-scores in honor of two famous educational psychologists, Lewis M. Thurman and Edward L. Thorndike. T-scores are in practical use limited to two digits with a mean of 50 and a normal deviate unit of 10. On the image projector you can see how the T-scores correspond to normal deviate values and also eliminate decimals and negatives.**

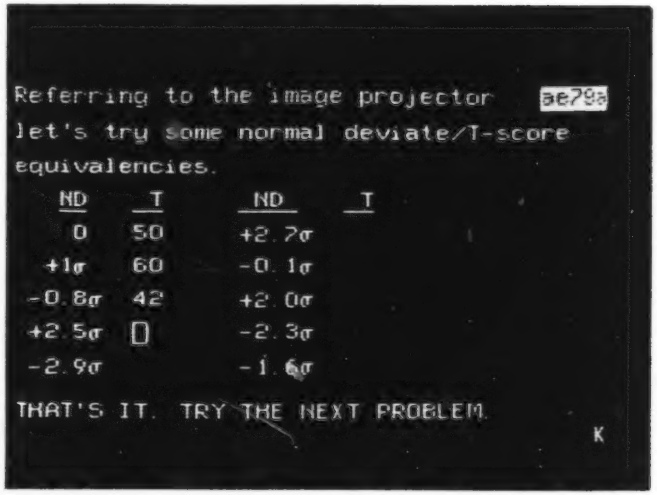
*134-Comment*

*The student is referred to 135-Image and in 136-CRT is required to convert normal deviate scores to T-scores. He has responded correctly to the first three problems, received feedback each time, and is ready to attempt the fourth problem.*

*135-Image*



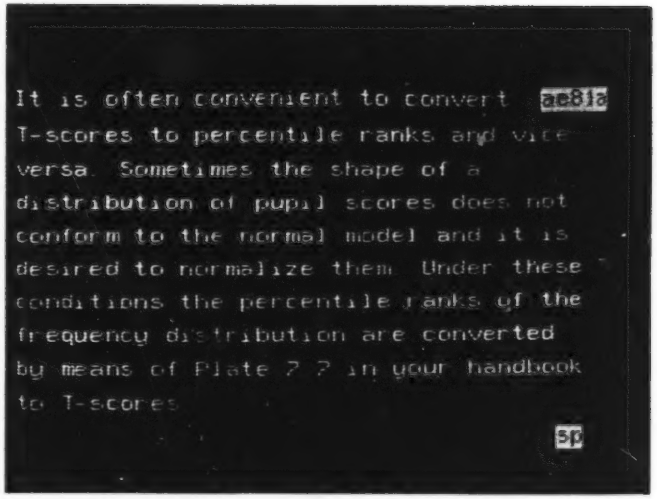

*136-CRT*



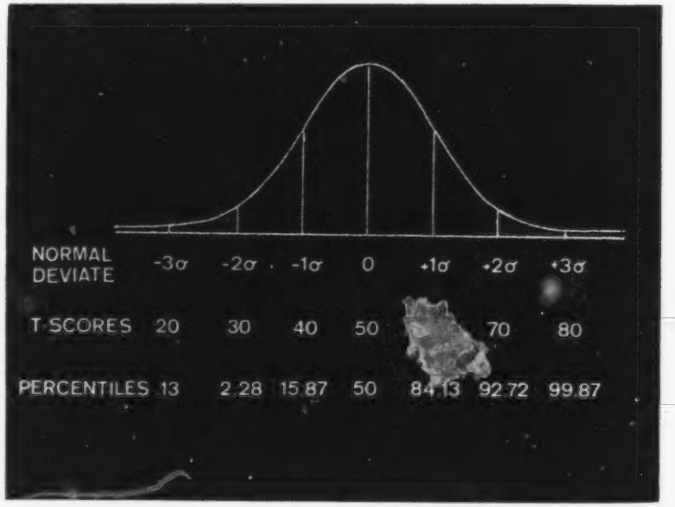

*137-Comment*

***138-CRT refers the student to Plate 7.7 in the student handbook which accompanies the course. The Plate is included in this documentation inside the back cover. 140-CRT requires the student to use the Table to convert T-scores to percentile rank.***

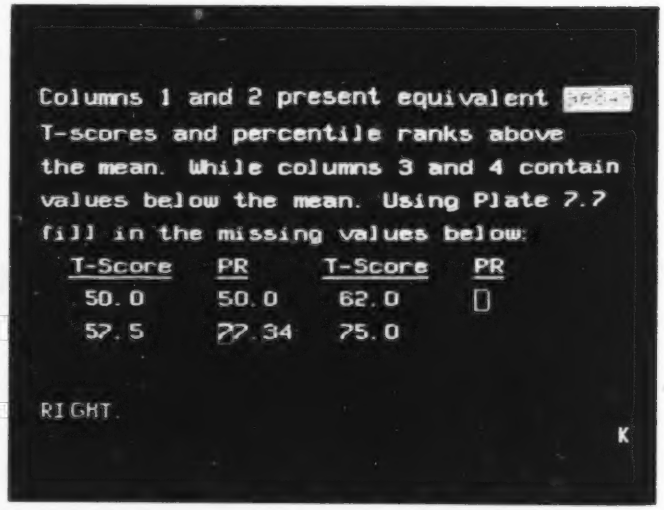
*138-CRT*


It is often convenient to convert ae81a
T-scores to percentile ranks and vice
versa. Sometimes the shape of a
distribution of pupil scores does not
conform to the normal model and it is
desired to normalize them. Under these
conditions the percentile ranks of the
frequency distribution are converted
by means of Plate ? ? in your handbook
to T-scores.
sp

*139-Image*



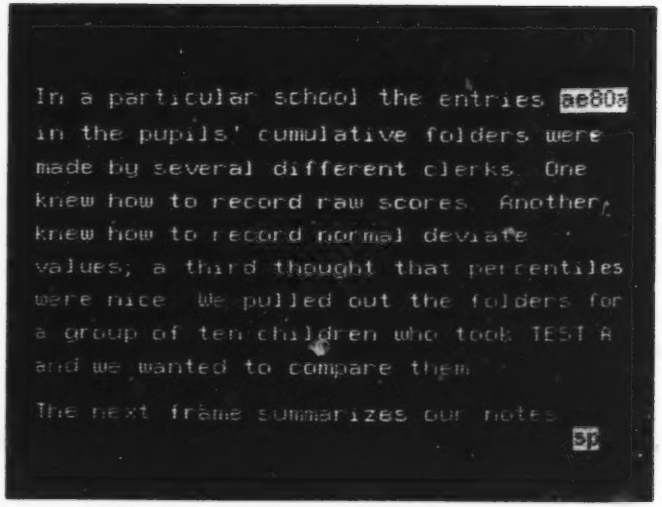

*140-CRT*


Columns 1 and 2 present equivalent
T-scores and percentile ranks above
the mean. While columns 3 and 4 contain
values below the mean. Using Plate 7.7
fill in the missing values below:
T-Score PR T-Score PR
50.0 50.0 62.0
52.5 77.34 75.0
RIGHT.
K

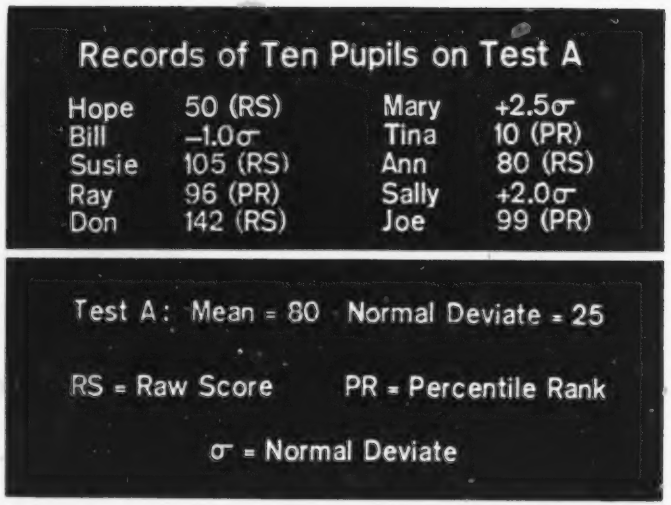
*141-Comment*

*The following materials provide a culminating exercise which causes the student to apply his recently acquired skills in converting normal deviate scores, percentile ranks, and raw scores to a single standard score distribution in order to make appropriate comparisons of the ability measured by a given test for a group of ten children.*

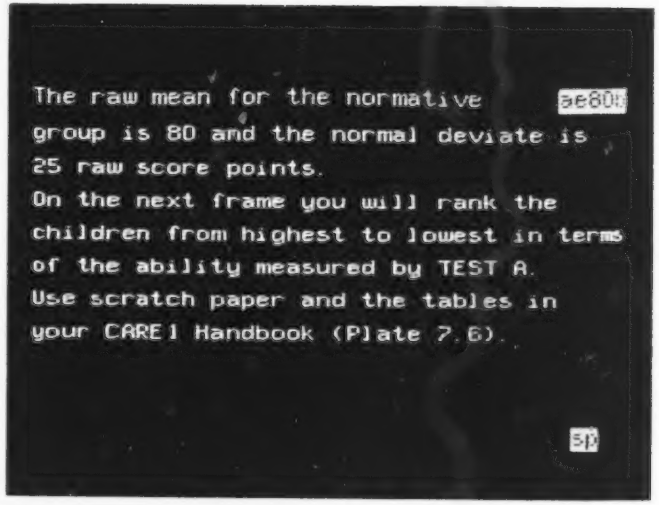
*142-CRT*


In a particular school the entries
in the pupils' cumulative folders were
made by several different clerks. One
knew how to record raw scores. Another
knew how to record normal deviate
values; a third thought that percentiles
were nice. We pulled out the folders for
a group of ten children who took TEST A
and we wanted to compare them.
The next frame summarizes our notes.

*143-Image*



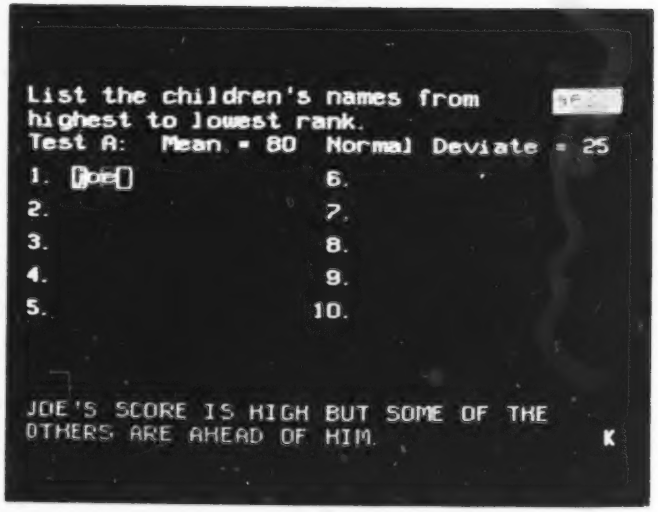

*144-CRT*


The raw mean for the normative group is 80 and the normal deviate is 25 raw score points.
On the next frame you will rank the children from highest to lowest in terms of the ability measured by TEST A.
Use scratch paper and the tables in your CARE1 Handbook (Plate 7.6).

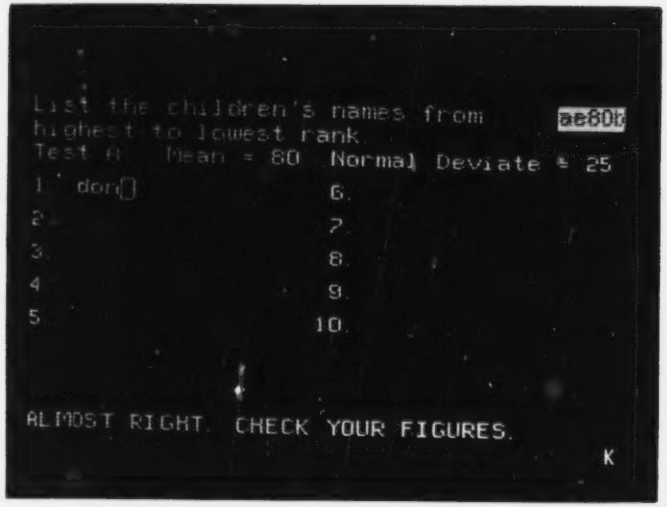
*145-Comment*

*The student responded (146-CRT), received feedback, and is required to respond again. 146-CRT through 150-CRT show the student's attempts to solve the problems.*

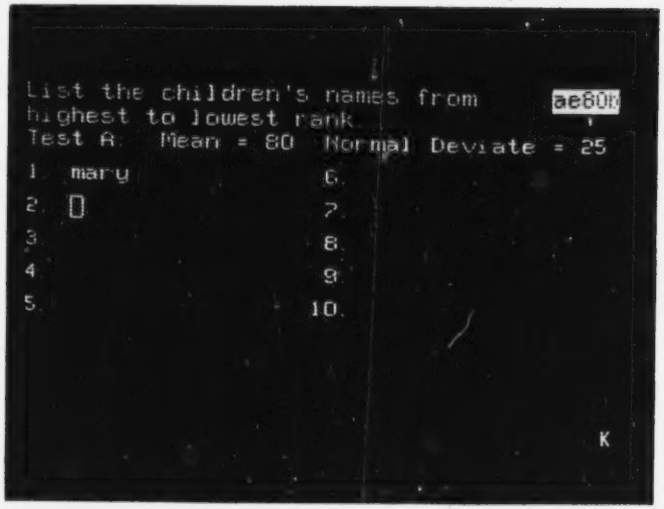
*146-CRT*



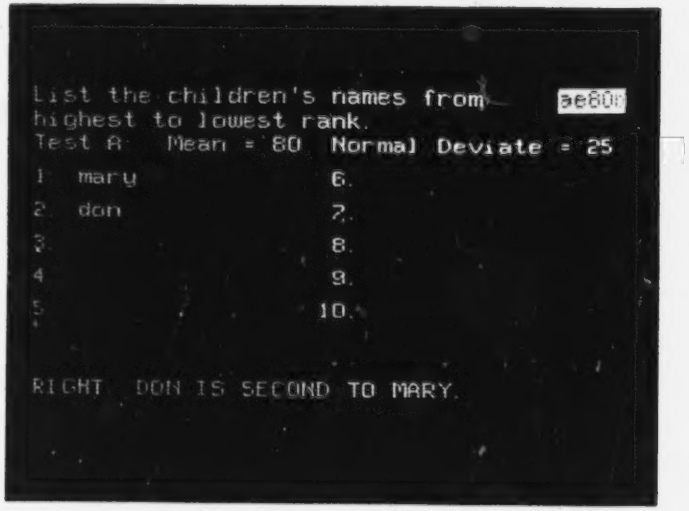
*147-CRT*



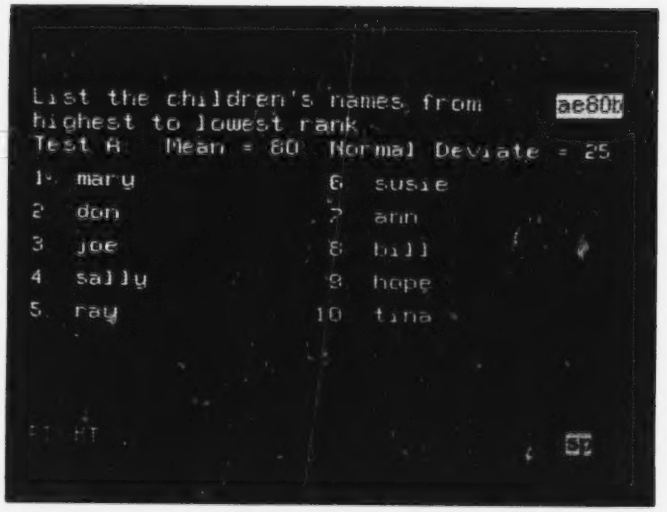

*148-CRT*




*149-CRT*




*150-CRT*



*151-CRT*

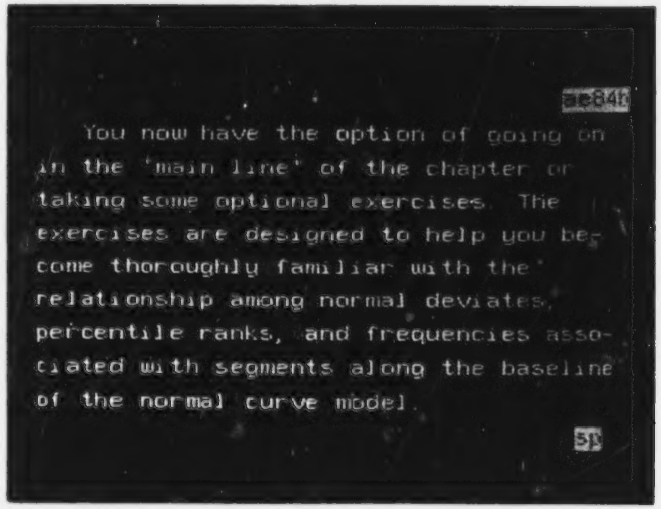

You now have the option of going on in the 'main line' of the chapter or taking some optional exercises. The exercises are designed to help you become thoroughly familiar with the relationship among normal deviates, percentile ranks, and frequencies associated with segments along the baseline of the normal curve model.

**PLATE 7.6**

**Areas of Normal Curve**

| (1) Normal Deviate (σ) | (2) Area From Mean to σ | (3) Area In Larger Portion | (4) Area In Smaller Portion | (1) Normal Deviate (σ) | (2) Area From Mean to σ | (3) Area In Larger Portion | (4) Area In Smaller Portion |
|---|---|---|---|---|---|---|---|
| 0.00 | .0000 | .5000 | .5000 | 0.40 | .1554 | .1554 | .3446 |
| 0.01 | .0040 | .5040 | .4960 | 0.41 | .1591 | .6591 | .3409 |
| 0.02 | .0080 | .5080 | .4920 | 0.42 | .1628 | .6628 | .3372 |
| 0.03 | .0120 | .5120 | .4880 | 0.43 | .1664 | .6664 | .3336 |
| 0.04 | .0160 | .5160 | .4840 | 0.44 | .1700 | .6700 | .3300 |
| 0.05 | .0199 | .5199 | .4801 | 0.45 | .1736 | .6736 | .3264 |
| 0.06 | .0239 | .5239 | .4761 | 0.46 | .1772 | .6772 | .3228 |
| 0.07 | .0279 | .5279 | .4721 | 0.47 | .1808 | .6808 | .3192 |
| 0.08 | .0319 | .5319 | .4681 | 0.48 | .1844 | .6844 | .3156 |
| 0.09 | .0359 | .5359 | .4641 | 0.49 | .1879 | .6879 | .3121 |
| 0.10 | .0398 | .5398 | .4602 | 0.50 | .1915 | .6915 | .3085 |
| 0.11 | .0438 | .5438 | .4562 | 0.51 | .1950 | .6950 | .3050 |
| 0.12 | .0478 | .5478 | .4522 | 0.52 | .1985 | .6985 | .3015 |
| 0.13 | .0517 | .5517 | .4483 | 0.53 | .2019 | .7019 | .2981 |
| 0.14 | .0557 | .5557 | .4443 | 0.54 | .2054 | .7054 | .2946 |
| 0.15 | .0596 | .5596 | .4404 | 0.55 | .2088 | .7088 | .2912 |
| 0.16 | .0636 | .5636 | .4364 | 0.56 | .2123 | .7123 | .2877 |
| 0.17 | .0675 | .5675 | .4325 | 0.57 | .2157 | .7157 | .2843 |
| 0.18 | .0714 | .5714 | .4286 | 0.58 | .2190 | .7190 | .2810 |
| 0.19 | .0753 | .5753 | .4247 | 0.59 | .2224 | .7224 | .2776 |
| 0.20 | .0793 | .5793 | .4207 | 0.60 | .2257 | .7257 | .2743 |
| 0.21 | .0832 | .5832 | .4168 | 0.61 | .2291 | .7291 | .2709 |
| 0.22 | .0871 | .5871 | .4129 | 0.62 | .2324 | .7324 | .2676 |
| 0.23 | .0910 | .5910 | .4090 | 0.63 | .2357 | .7357 | .2643 |
| 0.24 | .0948 | .5948 | .4052 | 0.64 | .2389 | .7389 | .2611 |
| 0.25 | .0987 | .5987 | .4013 | 0.65 | .2422 | .7422 | .2578 |
| 0.26 | .1026 | .6026 | .3974 | 0.66 | .2454 | .7454 | .2546 |
| 0.27 | .1064 | .6064 | .3936 | 0.67 | .2486 | .7486 | .2514 |
| 0.28 | .1103 | .6103 | .3897 | 0.68 | .2517 | .7517 | .2483 |
| 0.29 | .1141 | .6141 | .3859 | 0.69 | .2549 | .7549 | .2451 |
| 0.30 | .1179 | .6179 | .3821 | 0.70 | .2580 | .7580 | .2420 |
| 0.31 | .1217 | .6217 | .3783 | 0.71 | .2611 | .7611 | .2389 |
| 0.32 | .1255 | .6255 | .3745 | 0.72 | .2642 | .7642 | .2358 |
| 0.33 | .1293 | .6293 | .3707 | 0.73 | .2673 | .7673 | .2327 |
| 0.34 | .1331 | .6331 | .3669 | 0.74 | .2704 | .7704 | .2296 |
| 0.35 | .1368 | .6368 | .3632 | 0.75 | .2734 | .7734 | .2266 |
| 0.36 | .1406 | .6406 | .3594 | 0.76 | .2764 | 7764 | .2236 |
| 0.37 | .1443 | .6443 | .3557 | 0.77 | .2794 | .7794 | .2206 |
| 0.38 | .1517 | .6480 | .3520 | 0.78 | .2823 | 7823 | .2177 |
| 0.39 | .1517 | .6517 | .3483 | 0.79 | .2852 | 7852 | .2148 |

## PLATE 7.6

### Areas of Normal Curve

| (1) Normal Deviate ($\sigma$) | (2) Area From Mean to $\sigma$ | (3) Area In Larger Portion | (4) Area In Smaller Portion |
|---|---|---|---|
| 0.80 | .2881 | .7881 | .2119 |
| 0.81 | .2910 | .7910 | .2090 |
| 0.82 | .2939 | .7939 | .2061 |
| 0.83 | .2967 | .7967 | .2033 |
| 0.84 | .2995 | .7995 | .2005 |
| 0.85 | .3023 | .8023 | .1977 |
| 0.86 | .3051 | .8051 | .1949 |
| 0.87 | .3078 | .8078 | .1922 |
| 0.88 | .3106 | .8106 | .1894 |
| 0.89 | .3133 | .8133 | .1867 |
| 0.90 | .3159 | .8159 | .1841 |
| 0.91 | .3186 | .8186 | .1814 |
| 0.92 | .3212 | .8212 | .1788 |
| 0.93 | .3238 | .8238 | .1762 |
| 0.94 | .3264 | .8264 | .1736 |
| 0.95 | .3289 | .8289 | .1711 |
| 0.96 | .3315 | .8315 | .1685 |
| 0.97 | .3340 | .8340 | .1660 |
| 0.98 | .3365 | .8365 | .1635 |
| 0.99 | .3389 | .8389 | .1611 |
| 1.00 | .3413 | .8413 | .1587 |
| 1.01 | .3438 | .8438 | .1562 |
| 1.02 | .3461 | .8461 | .1539 |
| 1.03 | .3485 | .8485 | .1515 |
| 1.04 | .3508 | .8508 | .1492 |
| 1.05 | .3531 | .8531 | .1469 |
| 1.06 | .3554 | .8554 | .1446 |
| 1.07 | .3577 | .8577 | .1423 |
| 1.08 | .3599 | .8599 | .1401 |
| 1.09 | .3621 | .8621 | .1379 |
| 1.10 | .3643 | .8643 | .1357 |
| 1.11 | .3665 | .8665 | .1335 |
| 1.12 | .3686 | .8686 | .1314 |
| 1.13 | .3708 | .8708 | .1292 |
| 1.14 | .3729 | .8729 | .1271 |
| 1.15 | .3749 | .8749 | .1251 |
| 1.16 | .3770 | .8770 | .1230 |
| 1.17 | .3790 | .8790 | .1210 |
| 1.18 | .3810 | .8810 | .1190 |
| 1.19 | .3830 | .8830 | .1170 |
| 1.20 | .3849 | .8849 | .1151 |
| 1.21 | .3869 | .8869 | .1131 |
| 1.22 | .3888 | .8888 | .1112 |
| 1.23 | .3907 | .8907 | .1093 |
| 1.24 | .3925 | .8925 | .1075 |
| 1.25 | .3944 | .8944 | .1056 |
| 1.26 | .3962 | .8962 | .1038 |
| 1.27 | .3980 | .8980 | .1020 |
| 1.28 | .3997 | .8997 | .1003 |
| 1.29 | .4015 | .9015 | .0985 |
| 1.30 | .4032 | .9032 | .0968 |
| 1.31 | .4049 | .9049 | .0951 |
| 1.32 | .4066 | .9066 | .0934 |
| 1.33 | .4082 | .9082 | .0918 |
| 1.34 | .4099 | .9099 | .0901 |
| 1.35 | .4115 | .9115 | .0885 |
| 1.36 | .4131 | .9131 | .0869 |
| 1.37 | .4147 | .9147 | .0853 |
| 1.38 | .4162 | .9162 | .0838 |
| 1.39 | .4177 | .9177 | .0823 |
| 1.40 | .4192 | .9192 | .0808 |
| 1.41 | .4207 | .9207 | .0793 |
| 1.42 | .4222 | .9222 | .0778 |
| 1.43 | .4236 | .9236 | .0764 |
| 1.44 | .4251 | .9251 | .0749 |
| 1.45 | .4265 | .9265 | .0735 |
| 1.46 | .4279 | .9279 | .0721 |
| 1.47 | .4292 | .9292 | .0708 |
| 1.48 | .4306 | .9306 | .0694 |
| 1.49 | .4319 | .9319 | .0681 |
| 1.50 | .4332 | .9332 | .0668 |
| 1.51 | .4345 | .9345 | .0655 |
| 1.52 | .4357 | .9257 | .0643 |
| 1.53 | .4370 | .9370 | .0630 |
| 1.54 | .4382 | .9382 | .0618 |
| 1.55 | .4394 | .9394 | .0606 |
| 1.56 | .4406 | .9406 | .0594 |
| 1.57 | .4418 | .9418 | .0582 |
| 1.58 | .4429 | .9429 | .0571 |
| 1.59 | .4441 | .9441 | .0559 |

**PLATE 7.6**

**Areas of Normal Curve**

| (1) Normal Deviate (σ) | (2) Area From Mean to σ | (3) Area In Larger Portion | (4) Area In Smaller Portion | (1) Normal Deviate (σ) | (2) Area From Mean to σ | (3) Area In Larger Portion | (4) Area In Smaller Portion |
|---|---|---|---|---|---|---|---|
| 2.40 | .4918 | .9918 | .0082 | 2.80 | .4974 | .9974 | .0026 |
| 2.41 | .4920 | .9920 | .0080 | 2.81 | .4975 | .9975 | .0025 |
| 2.42 | .4922 | .9922 | .0078 | 2.82 | .4976 | .9976 | .0024 |
| 2.43 | .4925 | .9925 | .0075 | 2.83 | .4977 | .9977 | .0023 |
| 2.44 | .4927 | .9927 | .0073 | 2.84 | .4977 | .9977 | .0023 |
| 2.45 | .4929 | .9929 | .0071 | 2.85 | .4978 | .9978 | .0022 |
| 2.46 | .4931 | .9931 | .0069 | 2.86 | .4979 | .9979 | .0021 |
| 2.47 | .4932 | .9932 | .0068 | 2.87 | .4979 | .9979 | .0021 |
| 2.48 | .4934 | .9934 | .0066 | 2.88 | .4980 | .9980 | .0020 |
| 2.49 | .4936 | .9936 | .0064 | 2.89 | .4981 | .9981 | .0019 |
| 2.50 | .4938 | .9938 | .0062 | 2.90 | .4981 | .9981 | .0019 |
| 2.51 | .4940 | .9940 | .0060 | 2.91 | .4982 | .9982 | .0018 |
| 2.52 | .4941 | .9941 | .0059 | 2.92 | .4982 | .9982 | .0018 |
| 2.53 | .4943 | .9943 | .0057 | 2.93 | .4983 | .9983 | .0017 |
| 2.54 | .4945 | .9945 | .0055 | 2.94 | .4984 | .9984 | .0016 |
| 2.55 | .4946 | .9946 | .0054 | 2.95 | .4984 | .9984 | .0016 |
| 2.56 | .4948 | .9948 | .0052 | 2.96 | .4985 | .9985 | .0015 |
| 2.57 | .4949 | .9949 | .0051 | 2.97 | .4985 | .9985 | .0015 |
| 2.58 | .4951 | .9951 | .0049 | 2.98 | .4986 | .9986 | .0014 |
| 2.59 | .4952 | .9952 | .0048 | 2.99 | .4986 | .9986 | .0014 |
| 2.60 | .4953 | .9953 | .0047 | 3.00 | .4987 | .9987 | .0013 |
| 2.61 | .4955 | .9955 | .0045 | | | | |
| 2.62 | .4956 | .9956 | .0044 | | | | |
| 2.63 | .4747 | .9957 | .0043 | | | | |
| 2.64 | .4959 | .9959 | .0041 | | | | |
| 2.65 | .4960 | .9960 | .0040 | | | | |
| 2.66 | .4961 | .9961 | .0039 | | | | |
| 2.67 | .4962 | .9962 | .0038 | | | | |
| 2.68 | .4963 | .9963 | .0037 | | | | |
| 2.69 | .4964 | .9964 | .0036 | | | | |
| 2.70 | .4965 | .9965 | .0035 | | | | |
| 2.71 | .4966 | .9966 | .0034 | | | | |
| 2.72 | .4967 | .9967 | .0033 | | | | |
| 2.73 | .4968 | .9968 | .0032 | | | | |
| 2.74 | .4969 | .9969 | .0031 | | | | |
| 2.75 | .4970 | .9970 | .0030 | | | | |
| 2.76 | .4971 | .9971 | .0029 | | | | |
| 2.77 | .4972 | .9972 | .0028 | | | | |
| 2.78 | .4973 | .9973 | .0027 | | | | |
| 2.79 | .4974 | .9974 | .0026 | | | | |

## PLATE 7.6

### Areas of Normal Curve

| (1) Normal Deviate ($\sigma$) | (2) Area From Mean to $\sigma$ | (3) Area In Larger Portion | (4) Area In Smaller Portion | (1) Normal Deviate ($\sigma$) | (2) Area From Mean to $\sigma$ | (3) Area In Larger Portion | (4) Area In Smaller Portion |
|---|---|---|---|---|---|---|---|
| 1.60 | .4452 | .9452 | .0548 | 2.00 | .4772 | .9772 | .0228 |
| 1.61 | .4463 | .9463 | .0537 | 2.01 | .4778 | .9778 | .0222 |
| 1.62 | .4474 | .9474 | .0526 | 2.02 | .4783 | .9783 | .0217 |
| 1.63 | .4484 | .9484 | .0516 | 2.03 | .4788 | .9788 | .0212 |
| 1.64 | .4495 | .9495 | .0505 | 2.04 | .4793 | .9793 | .0207 |
| 1.65 | .4505 | .9505 | .0495 | 2.05 | .4798 | .9798 | .0202 |
| 1.66 | .4515 | .9515 | .0485 | 2.06 | .4803 | .9803 | .0197 |
| 1.67 | .4525 | .9525 | .0475 | 2.07 | .4808 | .9808 | .0192 |
| 1.68 | .4535 | .9535 | .0465 | 2.08 | .4812 | .9812 | .0188 |
| 1.69 | .4545 | .9545 | .0455 | 2.09 | .4817 | .9817 | .0183 |
| 1.70 | .4554 | .9554 | .0446 | 2.10 | .4821 | .9821 | .0179 |
| 1.71 | .4564 | .9564 | .0436 | 2.11 | .4826 | .9826 | .0174 |
| 1.72 | .4573 | .9573 | .0427 | 2.12 | .4830 | .9830 | .0170 |
| 1.73 | .4582 | .9582 | .0418 | 2.13 | .4834 | .9834 | .0166 |
| 1.74 | .4591 | .9591 | .0409 | 2.14 | .4838 | .9838 | .0162 |
| 1.75 | .4599 | .9599 | .0401 | 2.15 | .4842 | .9842 | .0158 |
| 1.76 | .4608 | .9608 | .0392 | 2.16 | .4846 | .9846 | .1054 |
| 1.77 | .4616 | .9616 | .0384 | 2.17 | .4850 | .9850 | .0150 |
| 1.78 | .4625 | .9625 | .0375 | 2.18 | .4854 | .9854 | .0146 |
| 1.79 | .4633 | .9633 | .0367 | 2.19 | .4857 | .9857 | .0143 |
| 1.80 | .4641 | .9641 | .0359 | 2.20 | .4861 | .9861 | .0139 |
| 1.81 | .4649 | .9649 | .0351 | 2.21 | .4864 | .9864 | .0136 |
| 1.82 | .4656 | .9656 | .0344 | 2.22 | .4868 | .9868 | .0132 |
| 1.83 | .4664 | .9664 | .0336 | 2.23 | .4871 | .9871 | .0129 |
| 1.84 | .4671 | .9671 | .0329 | 2.24 | .4875 | .9875 | .0215 |
| 1.85 | .4678 | .9678 | .0322 | 2.25 | .4878 | .9878 | .0122 |
| 1.86 | .4686 | .9686 | .0314 | 2.26 | .4881 | .9881 | .0119 |
| 1.87 | .4693 | .9693 | .0307 | 2.27 | .4884 | .9884 | .0116 |
| 1.88 | .4699 | .9699 | .0301 | 2.28 | .4887 | .9887 | .0113 |
| 1.89 | .4706 | .9706 | .0294 | 2.29 | .4890 | .9890 | .0110 |
| 1.90 | .4713 | .9713 | .0287 | 2.30 | .4893 | .9893 | .0107 |
| 1.91 | .4719 | .9719 | .0281 | 2.31 | .4896 | .9896 | .0104 |
| 1.92 | .4726 | .9726 | .0274 | 2.32 | .4898 | .9898 | .0102 |
| 1.93 | .4732 | .9732 | .0268 | 2.33 | .4901 | .9901 | .0099 |
| 1.94 | .4738 | .9738 | .0262 | 2.34 | .4904 | .9904 | .0096 |
| 1.95 | .4744 | .9744 | .0256 | 2.35 | .4906 | .9906 | .0094 |
| 1.96 | .4750 | .9750 | .0250 | 2.36 | .4909 | .9909 | .0091 |
| 1.97 | .4756 | .9756 | .0244 | 2.37 | .4911 | .9911 | .0089 |
| 1.98 | .4761 | .9761 | .0239 | 2.38 | .4913 | .9913 | .0087 |
| 1.99 | .4767 | .9767 | .0233 | 2.39 | .4916 | .9916 | .0084 |

PLATE 7.7

**Area T-Scores in Terms of Percentile Ranks**

| PERCENTILE RANK | | | |
|---|---|---|---|
| T-Score | Above Mean | Below Mean | T-Score |
| 50.0 | 50.00 | 50.00 | 50.0 |
| 50.5 | 51.99 | 48.01 | 49.5 |
| 51.0 | 53.98 | 46.02 | 49.0 |
| 51.5 | 55.96 | 44.04 | 48.5 |
| 52.0 | 57.93 | 42.07 | 48.0 |
| 52.5 | 59.87 | 40.13 | 47.5 |
| 53.0 | 61.79 | 38.21 | 47.0 |
| 53.5 | 63.68 | 36.32 | 46.5 |
| 54.0 | 65.54 | 34.46 | 46.0 |
| 54.5 | 67.36 | 32.64 | 45.5 |
| 55.0 | 69.15 | 30.85 | 45.0 |
| 55.5 | 70.88 | 29.12 | 44.5 |
| 56.0 | 72.57 | 27.43 | 44.0 |
| 56.5 | 74.22 | 25.78 | 43.5 |
| 57.0 | 75.80 | 24.20 | 43.0 |
| 57.5 | 77.34 | 22.66 | 42.5 |
| 58.0 | 78.81 | 21.19 | 42.0 |
| 58.5 | 80.23 | 19.77 | 41.5 |
| 59.0 | 81.59 | 18.41 | 41.0 |
| 59.5 | 82.89 | 17.11 | 40.5 |
| 60.0 | 84.13 | 15.87 | 40.0 |
| 60.5 | 85.31 | 14.69 | 39.5 |
| 61.0 | 86.43 | 13.57 | 39.0 |
| 61.5 | 87.49 | 12.51 | 38.5 |
| 62.0 | 88.49 | 11.51 | 38.0 |
| 62.5 | 89.44 | 10.56 | 37.5 |
| 63.0 | 90.32 | 9.68 | 37.0 |
| 63.5 | 91.15 | 8.85 | 36.5 |
| 64.0 | 91.92 | 8.08 | 36.0 |
| 64.5 | 92.65 | 7.35 | 35.5 |
| 65.0 | 93.32 | 6.68 | 35.0 |
| 65.5 | 93.94 | 6.06 | 34.5 |
| 66.0 | 94.52 | 5.48 | 34.0 |
| 66.5 | 95.05 | 4.95 | 33.5 |
| 67.0 | 95.54 | 4.46 | 33.0 |

| PERCENTILE RANK | | | |
|---|---|---|---|
| T-Score | Above Mean | Below Mean | T-Score |
| 67.5 | 95.99 | 4.01 | 32.5 |
| 68.0 | 96.41 | 3.59 | 32.0 |
| 68.5 | 96.78 | 3.22 | 31.5 |
| 69.0 | 97.13 | 2.87 | 31.0 |
| 69.5 | 97.44 | 2.56 | 30.5 |
| 70.0 | 97.72 | 2.28 | 30.0 |
| 70.5 | 97.98 | 2.02 | 29.5 |
| 71.0 | 98.21 | 1.79 | 29.0 |
| 71.5 | 98.42 | 1.58 | 28.5 |
| 72.0 | 98.61 | 1.39 | 28.0 |
| 72.5 | 98.78 | 1.22 | 27.5 |
| 73.0 | 98.93 | 1.07 | 27.0 |
| 73.5 | 99.06 | 0.94 | 26.5 |
| 74.0 | 99.18 | 0.82 | 26.0 |
| 74.5 | 99.29 | 0.71 | 25.5 |
| 75.0 | 99.38 | 0.62 | 25.0 |
| 75.5 | 99.46 | 0.54 | 24.5 |
| 76.0 | 99.53 | 0.47 | 24.0 |
| 76.5 | 99.60 | 0.40 | 23.5 |
| 77.0 | 99.65 | 0.35 | 23.0 |
| 77.5 | 99.70 | 0.30 | 22.5 |
| 78.0 | 99.74 | 0.26 | 22.0 |
| 78.5 | 99.78 | 0.22 | 21.5 |
| 79.0 | 99.81 | 0.19 | 21.0 |
| 79.5 | 99.84 | 0.16 | 20.5 |
| 80.0 | 99.87 | 0.13 | 20.0 |